GROUNDWATER GOVERNANCE AND MANAGEMENT IN NJOMBE DISTRICT, TANZANIA

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EXTENDED ABSTRACT

Groundwater resource in Tanzania faces challenges such as low awareness of the local communities about groundwater management, pollution, unplanned and uncontrolled exploitation. The general objective of this study was to examine groundwater governance for groundwater management in Njombe District. Data collection took place between September and November 2019. The study adopted a cross-sectional research design with qualitative and quantitative techniques. Qualitative data were collected using key informant interviews and focus group discussions whereas household survey was used to collect quantitative data. Purposive sampling procedure was used to select divisions and wards. A simple random sampling technique was used to select one village from each ward. From the sampling frame, a total of 250 households were selected. The IMB Statistical Products and Service Solutions version 20 was used to summarize quantitative data while qualitative data were subjected to content analysis. A Summated Index Scale (SIS) with five-point index scale was used to quantify groundwater governance. The *Kruskal Wallis H Test* and the *Mann Whitney U Test* were used to compare responses between villages and males and females respectively. The ordinal logistic regression model was used to determine the governance principles and groundwater characteristics factors that influenced groundwater users' compliance with groundwater institutions. Chi-squire test was also used to determine the respondents' socio-demographic characteristics that influenced groundwater users' compliance with groundwater institutions. The results showed that only three governance principles out of eight were well practised while other governance principles were poorly practised. The study concludes that the practice of governance principles was poor, hence affecting groundwater management in the study area. The overall level of groundwater governance was low and differed by governance principles. Groundwater governance actors interacted to manage public groundwater

points. However, groundwater governance encountered insufficient control over information flow among governance structures. The study recommends that groundwater governance structures have to maintain and improve their interaction to enhance effective groundwater management. The district should provide capacity building related to interactions particularly on efficient control of information flow and linking with other governance structures for groundwater governance and management matters at a local level. Based on the ordinal logistic regression analysis, compliance was mainly influenced by availability of groundwater (Wald = 7.694, p = 0.006), quality of groundwater (Wald = 20.408, p = 0.000) and participation (Wald = 13.397, p = 0.000). The results from Chi-squire test showed that compliance was also influenced by the distance from the respondents' households to groundwater points (p = 0. 006), sex (p = 0.000), education level (p = 0. 000) and the households annual income (p = 0.01). The study concludes that, groundwater characteristics in terms of quality and its availability, the practice of governance principles particularly participation in decision making, accessibility of groundwater, and socio-demographic characteristics are essential aspects to influence groundwater users' compliance with groundwater institutions. The study recommends that groundwater governance actors including the district water officials, village councils and COWSO leaders should practice well the good governance principles in the study area. Also the study recommends that local government authority and other water development stakeholders should increase number of groundwater points within the recommendable distance. The groundwater users' socio-demographic characteristics particularly sex, education level and annual households' income should be considered by groundwater governance actors to enhance effective groundwater management at the local level. This will increase the level of compliance with groundwater institutions.

DECLARATION

I, **JOHNSON LUNANILO GUDAGA,** do hereby declare to the Senate of Sokoine University of Agriculture, that this thesis is my own original work done in the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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DEDICATION

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LIST OF ABBREVIATIONS AND ACRONYMS

AMCOW	African Ministers' Council on Water
ANOVA	Analysis of Variance
CBWSO	Community Based Water Supply Organizations
CIT	Contextual Interaction Theory
COWSO	Community Owned Water Supply Organizations
CWC	Community Water Committee
CWMT	Community Water Management Team
FGDs	Focus Group Discussions
GGT	Good Governance Theory
IFAD	International Fund for Agricultural Development
IWRM	Integrated Water Resource Management
NAWAPO	National Water Policy
NBS	National Bureau of Statistics
NIT	New Institutional Theory
PNT	Policy Network Theory
RUWASA	Rural Water Supply and Sanitation Agency
SHIPO	Southern Highlands Participatory Organizations
SIS	Summated Index Scale
SNA	Social Network Analysis
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan African
UNDP	United Nations Development Program
URT	United Republic of Tanzania
UVINJO	*Uchimbaji wa Visima Njombe (*Njombe Drilling Groundwater Wells

	Group)
VEO	Village Executive Officer
VGAs	Village Government Authorities
WUAs	Water User Associations

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Water resource governance and management are aspects of global importance. Most of the Sub Saharan African (SSA) countries have water policies in place and legal frameworks that provide road map for water management (van Koppen *et al.,* 2016; Kabogo *et al.,* 2017). Such policies are in line with the Integrated Water Resource Management (IWRM) approach as a bold step towards effective water management (Setlhogile and Harvey, 2015; Mosha *et al.*, 2016; van Koppen *et al.*, 2016). The IWRM approach, which was agreed at the Dublin Conference on Water and Environment in 1992, highlights four principles for water resource management, namely, management of water based on hydrological boundaries, water management decentralization, water as an economic good, and stakeholder's participation in water management (Araral and Wang, 2013; Mosha *et al.*, 2016).

In the Tanzanian context, the National Water Policy (NAWAPO) of 2002 provides a framework for sustainable management of water. Thus, under the NAWAPO guidance, initiatives have been undertaken by the Tanzanian government in collaboration with development partners and other stakeholders to enhance effective groundwater management in the country. For instance, the government has strengthened the Basin Water Board Offices to carry out their mandated tasks through provision of equipment for data collection, building of Basin Water Laboratory offices, strengthening of water resource management institutions and formation of the WRM Acts of 2009 among others (URT, 2016). In addition, NAWAPO recognizes the importance of governance structures

at the local level to participate in groundwater management. The policy states that: “Water User Associations (WUAs) will be the lowest appropriate level of management and the associations will be responsible for local level management of allocated water resources” (URT, 2002). The intention of decentralization of water management, including groundwater, is to strengthen local communities’ involvement in water management like planning and implementing related activities (URT, 2002; 2009).

Groundwater remains prominent with regard to its contribution to the country’s socio-economic development. According to the Water Resource Group (2014), groundwater use in Tanzania accounts for over 25% of the water supply for domestic use, livestock, agriculture and sustaining ecosystems. Scholars, including Sangea *et al*. (2018), found that Tanzania uses about 1 265 000 m^3 of groundwater per day whereas half of this amount is used for water supply in rural areas. This connotes that groundwater is an imperative resource to enhance people’s livelihoods in the country. The importance of groundwater use is not only reported in Tanzania, but also in other countries in the world. Literature shows that majority of the population in SSA, depends on groundwater for various purposes including domestic use and irrigation activities (Xu *et al*., 2019). However, scholars including Sappa and Lucian (2014) and Komakech and Bont (2018) reported various groundwater challenges such as uncontrolled groundwater exploitation and pollution in some parts of Tanzania. In addition, high chloride concentration is another issue which encounters groundwater in some parts of country including Lindi, Mtwara, Singida, and Shinyanga regions (Sangea *et al*., 2018). The same source shows that groundwater in Lindi and Mtwara also experiences higher concentration of carbon dioxide. Other issues include high fluoride concentration in Kilimanjaro, Arusha, Singida and parts of Shinyanga regions and high iron concentration in Mtwara and Kagera

regions. These issues suggest that groundwater resource, like other natural resources, requires effective governance for its management in the country.

The concepts of groundwater governance and groundwater management are differentiated by their definitions in the literature. For instance, Megdal *et al*. (2015) define groundwater governance as a comprehensive framework which encompasses laws, regulations and customs for groundwater use as well as the engagement of the public sector and civil society in governing groundwater. Others scholars, like UNDP (2013), define water governance as decisions established to manage the water resource based on a certain policy background. In addition, literature shows that good governance goes concurrently with governance principles that include transparency, accountability, rule of law, responsiveness, collaboration, equitability, and efficiency (Burns *et al*., 2004; Hoekstra, 2006; Lockwood *et al.*, 2010; Garduño *et al*., 2011; Zaag and Savenije, 2014; Stefano *et al.*, 2014; Tarlock, 2015). The concept of groundwater management is defined as a practical social response with a given means or conditions to sustain water resource in a particular area (Toonen, 2011). This study defines groundwater governance as the presence of groundwater institutions such as laws, regulations and customs used by the responsible water governance structures to enhance groundwater management in the country whereas groundwater management is defined as routine activities, like protection of groundwater sources from pollution, paying water charges and protecting groundwater infrastructures from destruction among others, that are performed by groundwater users (URT, 2009).

Principally, effective groundwater governance is necessary to achieve the objective of Water Resource Management Act (WRMA) No. 12 of 2009 which aims to “promote and

ensure the right of every person in Tanzania to have access to efficient, effective and sustainable water supply and sanitation services for all purposes" (URT, 2009). It is clear that the access to efficient, effective and sustainable water supply and sanitation services call for the involvement of groundwater users to undertake groundwater management activities in a particular locality. Thus, one can point out that groundwater governance leads to groundwater management, which has to do with groundwater users' compliance with groundwater institutions. Scholars including Sweyaa *et al*. (2018), emphasize that failure to comply with water rules leads to poor water management in general. Therefore, prevalence of groundwater pollution and malfunctioning of groundwater infrastructures in various parts in Tanzania, as reported by Sappa and Lucian (2014), URT (2016) and Lufingo (2019), suggests that groundwater users' compliance with groundwater institutions is questionable.

In Tanzania, the Ministry of Water decentralized water governance through the National Water Policy (NAWAPO). The decentralization involves various governance structures such as Community Owned Water Supply Organizations (COWSOs), village councils, district councils and Water River Basin Authorities. The NAWAPO also recognizes the role of private sector in enhancing groundwater management in the country (URT, 2002). The NAWAPO through its Water Resource Management Act No. 12 of 2009 describes the functions of each water governance structure. For instance, COWSOs have to submit financial reports to the village councils while the district council has a role of allocating funds for water supply and sanitation projects and approving by-laws for protection of water sources among others. In addition, the River Water Basin Authority is accountable for providing water permit to drill groundwater and supervise general groundwater management (URT, 2002). Definitely, groundwater governance structures are

interdependent in enhancing groundwater management at various levels. Thus, the existing groundwater governance structures or actors should interact when undertaking their functions. Zheng (2010) shows that, interaction of different governance structures, through sharing knowledge, experience and resources, is important for effective resource management.

1.2 Statement of the Problem

For sustainable groundwater use and development, the Tanzania's NAWAPO of 2002 suggests effective groundwater management by enhancing systems for controlling pollution, procedures and guidelines governing exploitation, transparency, multi-sectors involvement and accountability, among others (URT, 2002; URT, 2009). Although the NAWAPO states explicitly how groundwater should sustainably be managed, its effectiveness is questionable since it is deterred by a number of challenges. In Njombe District, groundwater is overwhelmed by a number of challenges such as pollution due to infiltrated chemicals used for agricultural activities and massive illegal groundwater exploitation, among others (Arduino *et al.*, 2012; URT, 2016). If uncontrolled, the use of agrochemicals near groundwater sources will continue to contaminate the groundwater resource, thereby jeopardizing the safety of groundwater (Arduino *et al.*, 2012). In addition, the district lacks proper sanitation facilities; open defecation results in contamination of water sources including groundwater which negatively affects human health (Safari *et al.*, 2019). All these challenges indicate that groundwater is not adequately managed in the district. The question why such inadequacies in groundwater management prevail while the country has water governance legal frameworks for managing groundwater is not clearly addressed in literature.

1.3 Justification of the Study

The justification for this study lies on the fact that it addresses water policy effectiveness in supporting groundwater management in Tanzania. This is because the study considerably reflects on the NAWAPO performance with regard to groundwater management through its implementers at the local level. Also, the study encourages the water sector and partners at the local level to address challenges that are hindering the effectiveness of NAWAPO implementation for groundwater management at the local level. Apart from that, the study reflects the performance of the National Water Policy towards attaining the aspirations of the 2025 National Development Vision. Specifically, the vision aims to enhance universal access to safe water among others (URT, 2002). To achieve the universal access to safe water which includes groundwater resource calls for effective water resource governance to enhance water management including groundwater in the country.

1.4 Objectives

1.4.1 Overall objective

The overall objective of the study was to assess the effectiveness of groundwater governance and management on compliance with groundwater institutions in Njombe District.

1.4.2 Specific objectives

The specific objectives were:

(i) To explore practice of the groundwater governance principles among groundwater governance actors in the study area.

(ii) To establish groundwater governance levels using governance principles in the study area.

(iii) To examine interactions among groundwater governance actors in the study area.

(iv) To determine influence of governance principles' practice, socio-demographic characteristics of groundwater users and groundwater characteristics on groundwater users' compliance with groundwater institutions.

1.5 Research Questions

(i) How are governance principles practised among groundwater governance actors in the study area?

(ii) To what extent are governance principles practised among groundwater governance actors in the study area?

(iii) How do groundwater governance actors interact to enhance groundwater governance and management in the study area?

(iv) What is the influence of governance principles practice, socio-demographic characteristics of groundwater users and groundwater characteristics on compliance with groundwater institutions?

1.6 Theoretical Framework

Theories related to governance have been used by different scholars to assess water governance and management. For instance, Seward (2015) in a study titled: Rethinking groundwater governance in South Africa, used the Feedback Theory to assess effectiveness of groundwater management. This theory puts an emphasis on the requirements of laws, availability of benchmarks for monitoring, presence of leaders' accountability with effective governance and ability to reflect and learn (Pollord and du Toit, 2011). Other scholars, including Mcheka (2015) have used Policy Implementation Theory to assess water management. This theory emphasizes three things: networked

governance, socio-political context and democratic turn, and new public management. This study was guided by four theories namely Good Governance Theory, New Institutional Theory, Contextual Interaction Theory and Policy Network Theory. The reason behind using these theories is that, the theories capture the variables that are involved in specific objectives of the study. Therefore, the theoretical arguments of the aforementioned theories were used as guidance for the study.

1.6.1 Good Governance Theory

Historically, this theory was developed by the United Nations Development Program and the World Bank in the early 1990s to help developing countries attain political and socio-economic development through good governance (Setyadiharja *et al*., 2017; Ekundayo, 2017; Keping, 2018). The main argument of this theory is that developing countries can achieve political and economic development if they exercise good governance in terms of how public institutions conduct public affairs and manage public resources in a preferred way. Therefore, the practice of governance principles like participation, rule of law, transparency, responsiveness, equality, collaboration, efficiency and accountability becomes imperative. Keping (2018) and Ekundayo (2017) successfully used the Good Governance Theory to quantify political governance using governance principles in Nigeria. This study used governance principles stipulated in the Good Governance Theory to quantify groundwater governance in Njombe District.

1.6.2 New Institutional Theory

The evolution of New Institutional Theory (NIT) goes back to the 1970s and early 1980s. The theory was developed by John Meyer and his colleagues including Brian Rowan and Richard Scott (Powell, 2007). The theory has been a useful guidance in social sciences

including management and political science studies in assessing compliance (Lang, 2019). The NIT claims that individuals' compliance with institutions is a very important aspect for successful implementation of a given policy (Lipnicka and Verhoeven, 2014). Therefore, limited individual's compliance with the institutions constrains the possibility of policies being implemented cordially. In applying the NIT thinking, the study established levels of compliance with groundwater institutions. Knowing the levels of compliance with institutions was useful in suggesting whether the study area had an effective groundwater management or not. One of the shortfalls of the NIT is that it does not involve the aspect of factors that can influence someone to comply with the institutions.

1.6.3 Contextual Interaction Theory

Literature, including Wildavsky (1973) and Pressman and Wildavsky (1973), shows that the Contextual Interaction Theory (CIT) was developed from policy implementation studies that began in the early 1970s. The theory has been used in different studies to assess the implementation of policies including water policy, energy and environmental management in various countries (Hueso and Bell, 2013; Owens and Bressers, 2013; Mohlakoana, 2014). The theory identifies three main characteristics of policy implementers or targets that can influence best policy implementation. These characteristics are the motives that drive their actions, cognition in terms of true information related to the implemented policy and resources that provide capacity to implement policy (Bressers, 2007). Owens and Bressers (2013) define implementer as an actor who is officially commissioned to realize policy implementation. This theory was useful in this study because one of the specific objectives was to determine factors that influenced compliance with institutions. Since the NIT does not comprise the aspect of

factors that can influence individuals to comply with institutions then the study used CIT to complement that shortfall.

Under this study, water governance actors including groundwater users through their COWSOs are the implementers of NAWAPO in the country (URT, 2002). Thus, groundwater users' compliance with institutions is critical for effective groundwater management. Based on CIT argument, individuals comply with institutions if they are motivated by some factors. Thus, this study assumed that the practice of good governance principles by the responsible governance structures can drive groundwater users to comply with respective institutions. In addition, the study puts that characteristics of groundwater like accessibility, availability and quality of groundwater can influence groundwater users to comply with institutions. Therefore, descriptive analysis of the governance principles levels and groundwater characteristics were used to determine factors that influenced groundwater users to comply with institutions.

1.6.4 Policy Network Theory

The Policy Network Theory was developed from different studies including organizational, economics, sociology, anthropology, public policy and political science since the 1970s (Berry *et al*., 2003; Hudson and Lowe, 2009). Literature, including Compston (2009) and Rhodes (1997), defines the concept of policy network as number of actors inside and outside governments who are involved in, or have an interest in influencing public policy implementation or relations between mutually dependent actors. In addition, the theory indicates games and game arenas as important concepts in policy processes. The concept of games refers to a series of interactions among actors with the aim of influencing the implementation of public policies whereas game arena(s) refers to

the places whereby games are played to influence public policy implementation (Scharpf, 1997; Koppenjan and Klijn, 2004). The PNT underscores the importance of interaction among various actors inside or outside the structure by sharing resources, information and experience among others to solve public policy problems (Zheng *et al*., 2010). Various scholars have used PNT in different purposes and contexts. For instance, Leach *et al*. (1999) used this theory to investigate mutual interactions of various policy actors with the environment they manage in South Africa and Ghana, whereas Jaffer (2013) adopted PNT in investigating the environmental policy process in Nairobi.

The PNT was relevant for this study because one of the study objectives was to assess interactions among groundwater governance actors in enhancing groundwater management. Thus, the theory guided the study to assess the interaction of the respective groundwater governance structures such as COWSOs, village councils, RUWASA, Rufiji Water Basin Authority, district councils, and the private sector at the local level. Under this study, the theory asserts that, mutual interaction of these responsible groundwater governance structures is a potential phenomenon towards effective groundwater management at the local level. According to Primmer (2011), the theory pays attention to ways in which actors communicate relative to, learn about, and influence natural resource management among them.

1.7 Conceptual Framework

Figure 1.1 depicts the relationship between groundwater governance structures and governance principles, groundwater characteristics and groundwater management, and the relationship between groundwater governance and groundwater management.

The study argues that groundwater management is driven by factors such as responsible governance structures to practise effectively the governance principles including transparency, accountability, participation, rule of law, collaboration, equitability, responsiveness and efficiency on matters related to groundwater management at the local level (Comte *et al.*, 2016; Kabogo *et al.*, 2017; Masifia and Sena, 2017; Nganyanyuka, 2017). The responsible governance structures at the local level include the Water River Basins, RUWASA, district councils, village councils, Community Water Supply Organizations (CoWSOs) and private sector actors among others (URT, 2002; 2009).

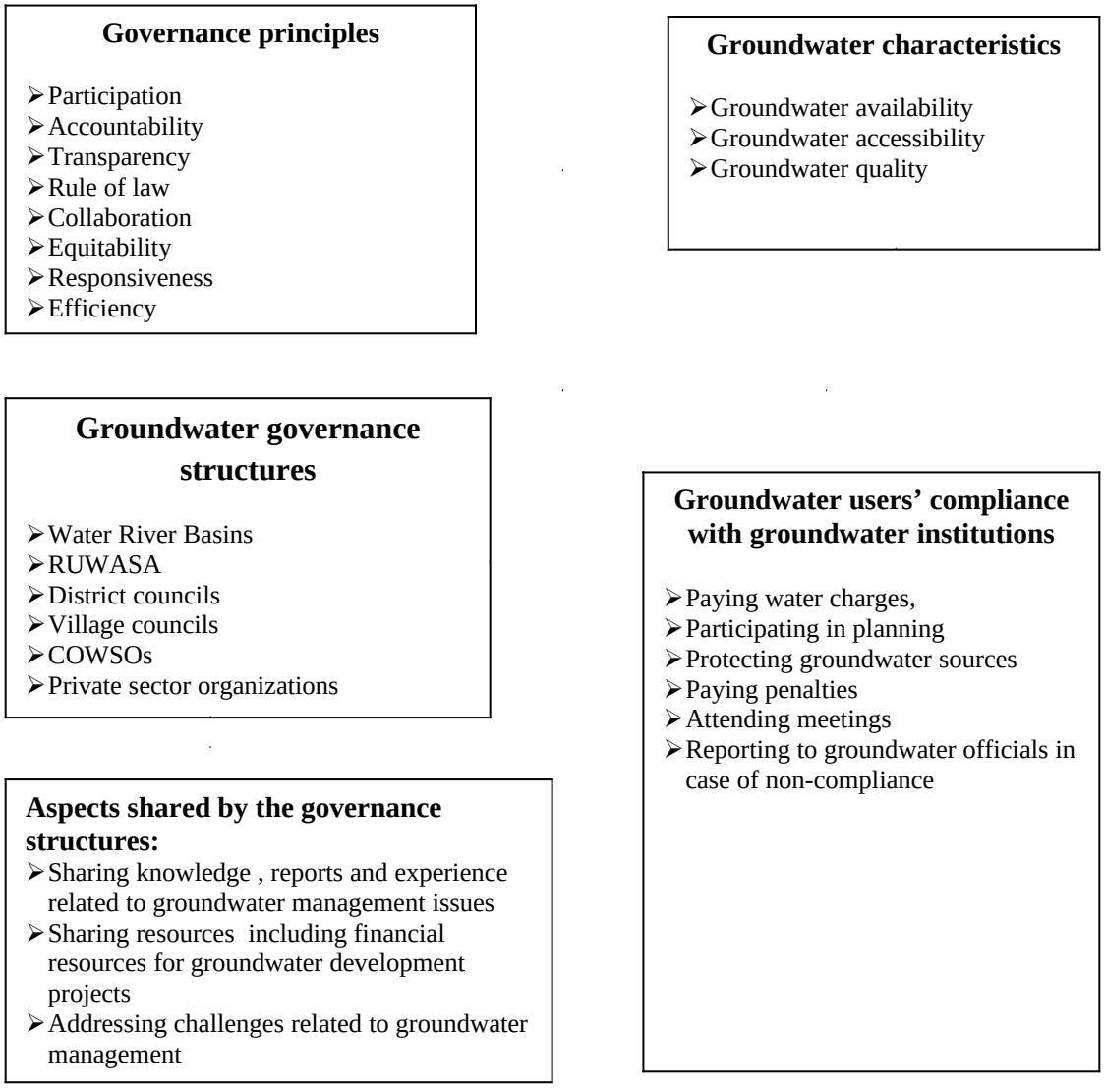

Figure 1.1: Groundwater governance for effective groundwater management

Groundwater governance and management emanate from availability of groundwater institutions and groundwater users' compliance with the institutions. Compliance in this regard involves paying water charges, participating in planning and decision making for various groundwater management, protecting groundwater sources from pollution, paying penalties, attending meetings that discuss groundwater management issues, and reporting to groundwater officials in case of non-compliance (Mandara *et al.,* 2013; Mandara, 2014; Comte *et al*., 2016). In addition, the study asserts that groundwater users are likely to comply with groundwater institutions if groundwater governance structures and or actors are well practicing governance principles (Comte *et al*., 2016; Kabogo *et al*., 2017). This study argues that groundwater users are motivated to comply with groundwater institutions when they realize that governance principles are well practiced by groundwater governance structures and/ or actors in a particular locality.

Also, the study asserts that the nature of groundwater such as its availability, quality and accessibility can influence groundwater users' compliance with groundwater institutions in their localities (Mechlem, 2016; Gudaga, 2018). Furthermore, the study argues that the interaction among groundwater governance structures or actors is an imperative aspect which can promote effective groundwater management at a local level. Such interaction among governance structures involves sharing knowledge, information, and skills related to groundwater management; sharing resources including financial resources and addressing challenges related to groundwater management in a particular area (URT, 2009; 2019).

1.8 General Methodology

1.8.1 Research design, sampling procedures and sample size

The study adopted a cross-sectional research design with a mixed method approach. This approach involves quantitative and qualitative techniques. The aim of the mixed approach

was to triangulate data collection methods. The design was appropriate for exploring information about the practice of governance principles and groundwater users' compliance with groundwater institutions.

Purposive sampling procedure was used to select Makambako and Lupembe divisions. Four wards of Mtwango, Kichiwa, Igongolo and Kidegembye were also purposively selected. The criterion for selecting divisions and wards was the availability of groundwater points. The information about the availability of groundwater points was obtained from RUWASA officials. Purposive sampling technique is recommended in social sciences because it focuses directly on the intended and appropriate area for study (Kothari, 2006). One village from each ward, making four villages in total was selected using simple random sampling. The sampling frame of this study comprised 670 households of the study villages. From the sampling frame, 250 households were selected. Simple random sampling was employed to select respondents at a household level mainly head of households and or spouses. The intention was to interview equal number of males and females because they are both stakeholders but with possibly different perspectives on groundwater governance because of different gender roles. When we interviewed a household head the next respondent was supposed to be a spouse, and vice versa, until the required sample size was reached with an equal number of male and female respondents.

1.8.2 Data collection methods and tools

Quantitative data were collected using household survey, guided by a structured questionnaire. Copies of questionnaire were administered to the household heads and or spouses who responded to the questions. This tool generated data related to, among others; the respondents' socio-economic and demographic characteristics and practice of

governance principles. Copies of questionnaire were translated in Swahili before being administered to the households. Qualitative data were collected through Focus Group Discussions (FGDs) and key informant interviews. One FGD was conducted in each village making a total of four FGDs. Each FGD comprised seven to nine groundwater users making a total of 32 participants. The proportion of women participants ranged from four to six per group. FGDs included males and females because both are responsible for groundwater management. A total of nine key informants, mainly leaders, from COWSOs, Village Government Authorities (VGAs) and RUWASA were involved. Both FGDs and key informant interviews were guided by a checklist of items.

1.8.3 Data analysis

Qualitative data were analysed using content analysis. This involved transcription of information collected through key informants and FGDs. SPSS version 20 was used to generate descriptive statistics of respondents' socio-economic and demographic characteristics. SPSS was also used to compute percentage distribution for various variables. The variables on the practice of governance principles and respondents' responses on compliance with groundwater institutions were assigned points based on a five-point index scale on which strongly agree was assigned 5 points, agree represented 4 points, neutral represented 3 points, disagree represented 2 points and strongly disagree represented 1 point. The *Kruskal Wallis H test* and the *Mann Whitney-U test* were used to compare differences of the respondents' responses in the villages and sex respectively on the level of groundwater governance at 5% level of significance. The Social Network Analysis (SNA) tool was used to establish interactions among groundwater governance actors. Software Gephi 0.9.2 (2008-2017) was used to generate image of interactions among governance actors in the study area.

The One-Way Analysis of Variance (ANOVA) was used to compare distance in metres from households to the groundwater points. Before the comparison, the normality of the mean distances was determined using Sharpiro-Wilk test; it showed no significant difference ($p > 0.05$) between the normal curve and the curve of the estimated distances from the households of groundwater users to groundwater points. This means that in the population from which the data were collected distance from home to water points were normally distributed. The Post hoc particularly Turkey's Honestly Significant Different (HSD) was used for multiple comparisons.

Ordinal logistic regression and Chi-square test of association were uses to determine factors that are likely to influence groundwater users' compliance with groundwater institutions. In addition, Variance Inflation Factor (VIF) test was used to check the existence of multicollinearity in the independent variables. The results showed no multicollinearity in the data set because all of the VIF values were less than 10 and the tolerance ranged between 0.888 and 0. 965. Furthermore, Pearson correlation coefficient was used to measure the strength of the association between two variables whereas the results ranged between -0.018 to 0.723. In addition, before data analysis, the Cronbach's Alpha was used to measure the inter-item consistency and reliability of ordinal data. The result of the Cronbanch's Alpha value was 0.729 indicating that the scale was reliable.

1.9 Thesis Organization

This thesis adopted publishable manuscript format and it is organized into six chapters. Chapter one comprises an introduction of the general theme of the thesis. Chapter two deals with the practice of governance principles among groundwater governance actors in the study area. Chapter three entails levels of groundwater governance using governance

principles whereas Chapter four deals with interaction among groundwater governance structures/actors in the study area. Chapter five deals with factors that influenced groundwater users' compliance with groundwater institutions. Lastly, chapter six covers the overall conclusions and recommendations.

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CHAPTER TWO

2.0 Practice of Governance Principles for Groundwater Management at the Local Level in Tanzania: A Case of Njombe District

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2.1 Abstract

Although Tanzania is struggling to improve water management, groundwater governance remains one of the pressing issues in the country. The general objective of this paper was to explore groundwater governance using governance principles. The specific objective of this paper was to explore the practice of governance principles for groundwater management at the local level in Tanzania. The study adopted a cross-sectional research design using the mixed methods approach and involved a random sample of 250 respondents. Qualitative data collection involved 32 participants in Focus Group Discussions (FGDs) and nine (9) key informants, mainly governance actors at the village and district levels, and Community Owned Water Supply Organizations (COWSOs). The Statistical Products and Service Solutions (SPSS) was used to summarize descriptive statistics while qualitative data were subjected to content analysis. The findings revealed that five (5) governance principles namely: accountability, transparency, collaboration, rule of law and responsiveness, out of eight (8) were not practised effectively. The study concludes that groundwater governance actors did not practice effectively the governance principles hence it can affect negatively groundwater management in the study area. The

governance actors especially COWSOs should effectively practise governance principles particularly transparency, collaboration, rule of law, responsiveness and collaboration.

Key words: Groundwater governance, Water governance actors, Njombe District, Tanzania

2.2 Introduction

Groundwater governance remains crucial to enhance effective groundwater water management world widely. Groundwater is an invisible water resource in which deliberate measures have been made by various governments to further its management. The International Conferences on Water and Environmental issues that were held in 1992 in Dublin-Ireland and in Rio de Janeiro- Brazil (Mosha *et al.*, 2016; Komakech and de Bont, 2018) established milestones of water management including groundwater in the respective countries. In the early 1990s after the aforementioned conferences, most of the Sub Saharan African countries adopted the Integrated Water Resource Management (IWRM) approach (Mosha *et al.*, 2016). The adoption of the IWRM aimed to strengthen water resource management through the decentralized frameworks of water governance in a particular countries (Araral and Wang, 2013; Mosha *et al.*, 2016; Komakech and de Bont, 2018). To that effect, effective groundwater governance is an essence to attain effective groundwater management in places.

This study adopted the Good Governance Theory to measure the practice of the groundwater governance principles in enhancing groundwater management in the study area. This theory was developed by the United Nations Development Program and the World Bank in the early 1990s with aim of supporting the developing countries on how to

achieve political and socio-economic development through good governance (Ekundayo, 2017; Keping, 2018). The theory connoted that the developing countries should exercise good governance by practising the governance principles like participation, rule of law, transparency, responsiveness, equality, collaboration, efficiency and accountability becomes imperative (UNDP, 1997; Burns *et al.*, 2004; Keping, 2018).

This paper used governance principles that are predetermined in the Good Governance Theory to explore whether they were practiced well or not by the groundwater governance actors to enhance groundwater management in the study area. The study believed that good practice of the governance principles suggested effective groundwater governance to enhance groundwater management while poor practice of the governance principles suggested inadequate groundwater governance to support groundwater management in Njombe District.

The concept of groundwater governance is defined differently in the literature. Some authors including Megdal *et al*. (2015) define it as a comprehensive framework which encompasses laws, regulations and customs for groundwater use as well as the engagement of the public sector and civil society in governing groundwater. Others like Foster *et al.* (2009) define groundwater governance as a collective action to enhance sustainable and efficient utilization of groundwater for the benefit of people and ecosystems in general. Furthermore, FAO (2013), adopted in this study, defines groundwater governance as managing groundwater through governance principles. An effective groundwater management requires a well-established groundwater governance system. This study conceptualizes groundwater management as routine activities like protection of groundwater sources from pollution, paying water charges and protecting

groundwater infrastructures from destruction. With that definition, it is logical to argue that the groundwater governance and management are inseparable because governance stands as a means that support groundwater management.

According to URT (2002), governance of water in Tanzania is regulated by statutory and customary laws. Maganga (2004) provides detailed information about customary norms and statutory laws for implementing Integrated Water Resource Management (IWRM) in the country since colonialism. The Ministry of Water, in Tanzania, decentralized water governance through the National Water Policy (NAWAPO). Such decentralization emphasizes community participation in the water sector including groundwater (URT, 2002; 2009; Zaag and Savenije, 2014; FAO, 2016). The National Water Policy (NAWAPO) of 2002 and Water Supply and Sanitation Act No. 12 of 2009 consider Community Owned Water Supply Organizations (COWSOs) as the only legal water governance actor at a local level in Tanzania. Literature, including Kabote and John (2018), succinctly shows that Village Councils and Water Users Associations are also imperative water governance and management actors in the country. COWSOs are becoming popular for water governance in Tanzania compared to other actors. Their function is basically governance which includes enforcing water charges payments, enforcing payment of penalties upon breach of water rules, limiting persons not complying with water rules from accessing water points, encouraging ownership of properties including water points, encouraging community participation in planning and implementation of groundwater management activities (URT, 2009; 2019b). Thus, COWSOs have legitimacy to influence groundwater users' behaviour and therefore critical for groundwater governance. Principally, COWSOs require practical application of governance principles to ensure best practice for groundwater governance.

In Njombe District, groundwater faces management issues like unsustainability of the installed wells and rope pumps (Holtslag and Mgina, 2016), poor awareness of where to exploit groundwater, beliefs that untreated groundwater is safe for human consumption, pollution and illegal groundwater exploitation (Arduino *et al.*, 2012; URT, 2016b). Such challenges suggest that governance actors do not practise groundwater governance principles effectively. The general objective of this paper was to explore groundwater governance using governance principles. The specific objective of this paper was to explore the practice of governance principles for groundwater management at the local level in Tanzania. The definitions of governance principles as applied in this study are shown in Table 2.1.

Table 2.1: Operational definitions of governance principles

Variable	Operational definition	Reference
Participation	Offering the community an opportunity for making decision, owning, planning and budgeting resources	UNDP (1997); Burns *et al*. (2004); Lockwood *et al.* (2010)
Accountability	Is a tendency of groundwater governance actors to be responsible for their actions in relation to groundwater management matters	Lockwood *et al*. (2010); Zaag and Savenije (2014)
Efficiency	Refers to the availability, accessibility and protection of groundwater resource	Abrha (2016)
Transparency	Availability and accessibility of information related to groundwater governance.	Sanz *et al*. (2016); Lockwood (2010)
Equitability	Providing equal opportunity to the community regardless their socio-demographic differences	UNDP (1997); Lockwood (2010).
Collaboration	Working actively together among different actors	Graham *et al.* (2003)
Responsiveness	Reacting actively and timely on groundwater management matters.	Abrha (2016)
Rule of law	Applying clearly and uniformly water rules to all groundwater users	Zaag and Savenije, (2014); Abrha (2016)

2.3 Methodology

2.3.1 The study area

The study was conducted in Njombe District, Njombe Region, Tanzania (Fig. 2.1). Data were collected between September and November, 2019. The District is divided into three district councils namely: Njombe Rural District Council, Njombe Urban Council and Makambako Town Council. The District receives an annual average rainfall of 1 500 mm (Madzengo, 2014), and it is characterised by a typical unimodal climate, that receives rainfall between November and April.

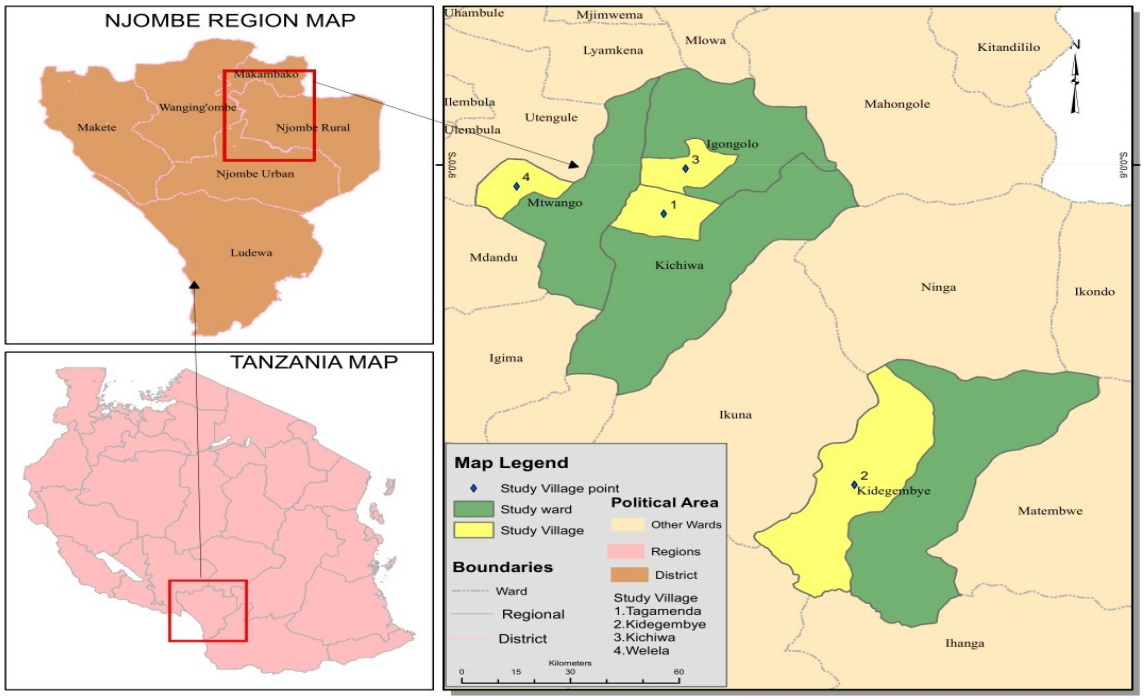

Figure 2.1: Location map of Njombe District showing the study area

The maximum monthly temperature is below 23.5°C almost all months, excluding November and December in which the average temperature is 24.7°C. The minimum temperature ranges between 12 and 15°C from November to April, and is lower than 8°C during June and July (Mtongori *et al*., 2015).

The water sources in the District include river Ruhuji and springs (URT, 2016b). About 80% of the population in Njombe District has access to clean and safe water (URT, 2019a). Various water projects have been established for water supply in the District and by 2016, the District had 65 water projects, 35 of them dealt with groundwater (URT, 2016a). This implies that groundwater sources account for 53.8% of all water projects implying that Njombe District was a proper case to explore groundwater governance principles.

2.3.2 Research design, sampling procedures and sample size

The study adopted a cross-sectional research design with a mixed method approach. This approach involves quantitative and qualitative techniques. The aim of the mixed approach was to triangulate data collection methods as argued by Creswell (2014). Cross-sectional research design was adopted because it is the best method when the researcher collects data for validation studies (Kesmodel, 2018). The design was appropriate for exploring information about governance principles.

Purposive sampling procedure was used to select Makambako and Lupembe divisions. Four wards of Mtwango, Kichiwa, Igongolo and Kidegembye were also purposively selected. The criterion for selecting divisions and wards was the availability of groundwater points. The information about the availability of groundwater points was obtained from RUWASA officials. Purposive sampling technique is recommended in social sciences because it focuses directly on the intended and appropriate area for study (Kothari, 2006). One village from each ward, making four villages in total was selected using simple random sampling. The sampling frame of this study comprised 670 households of the study villages. From the sampling frame, 250 households were selected.

Simple random sampling was employed to select respondents at a household level mainly head of households and or spouses. The intention was to interview equal number of males and females because they are both stakeholders but with possibly different perspectives on groundwater governance because of different gender roles. When we interviewed a household head the next respondent was supposed to be a spouse, and vice versa, until the required sample size was reached with an equal number of male and female respondents. The total sample size was determined by using the Yamane (1967) formula. This formula was used because the population size was known. One of the assumptions of the Yamane formula is that the population size should be finite (Louangrath and Sutanapong, 2019). The Yamane (1967) formula is expressed as:

$$n = \frac{N}{1+N(e)2} \quad \text{……(1)}$$

Where:

n = Sample size

N = Population size, and

e = Level of precision, which is 0.05.

Substituting the total number of households and the level of precision into equation 1, we get the total sample size equals to 250, that is:

$$\frac{670}{1+670(0.0)2} \mathrm{n} = 250.47 \approx 250$$

In order to ensure that the number of sampled households in a particular village was proportional to the total number of households, proportionate stratified sampling was used by using equation 2, and the sample size per village is shown in Table 2.2. By substituting the values into equation 2, we get sub-samples as shown in Table 2.2.

$$a = \frac{n}{N * b} \quad \text{.....(2)}$$

Where:

a = Sample size for each village

n = Total number of sampled households for 4 villages,

N = Target households for 4 villages, and

b = Target households in each village (Yamane, 1967)

Table 2.2: Number of sampled households and groundwater points in the selected villages

Village	Groundwater points	Number of households (N)	Sampled households (n)	Per cent (%)
Welela	6	210	78	31
Tagamenda	4	186	69	28
Kidegembye	6	154	58	23
Kichiwa	5	120	45	18
Total	**22**	**670**	**250**	**100**

2.3.3 Data collection methods and tools

Quantitative data were collected using household survey, guided by a structured questionnaire. Copies of the questionnaire were administered to the household heads and or spouses who responded to the questions. This tool generated data related to, among others, the respondents' socio-economic and demographic characteristics and governance principles (Appendix 2). Copies of questionnaire were translated in Swahili before being administered to the households.

Qualitative data were collected through Focus Group Discussions (FGDs) and key informant interviews. One FGD was conducted in each village making a total of four FGDs. Each FGD comprised seven to nine groundwater users making a total of 32 participants. The proportion of women participants ranged from four to six per group. FGDs included males and females because both are responsible for groundwater

management. FGDs are useful to generate qualitative information through discussion on the topic at hand (Creswell, 2014). A total of nine key informants, mainly leaders, from COWSOs, Village Government Authorities (VGAs) and RUWASA were involved. Both FGDs and key informant interviews were guided by a checklist of items.

2.3.4 Data analysis

Qualitative data were analysed using content analysis. This involved transcription of information collected through key informants and FGDs. For quantitative data, the variables of governance principles were assigned points based on a five-point index scale on which strongly agree was assigned 5 points, agree represented 4 points, neutral represented 3 points, disagree represented 2 points and strongly disagree represented 1 point. During data analysis, the five-point index scale was collapsed into a three–point scale, which is agree, neutral and disagree in order to ease interpretation. Then, the number of respondents for each statement was counted to get the percentage distribution for agree, neutral and disagree. According to Pallant (2007), a three-point scale is appropriate for measuring social attributes such as attitude, awareness, perceptions, and knowledge.

The One-Way Analysis of Variance (ANOVA) was used to compare the mean distance in metres from households to the groundwater points. The following formula as used by Ostertagagova and Ostertag (2013) was used to calculate the mean distance.

$$\bar{x_i} = \frac{1}{n_i} \frac{\sum_{j=1}^{n_i} x_{ij}}{n_i} \quad \text{..... (3)}$$

Where:

$\bar{x}_i$= Mean distance of the i^{th} group (village)

n_i=Number of observations in the i^{th} group (village)

x_{ij}= Value of i^{th} observation at the i^{th} factor level (village)

To determine the normality of data, the Sharpiro-Wilk test was used and showed no significant difference (P > 0.05) between the normal curve and the curve of the estimated distances from the households of groundwater users to groundwater points. This implies that the population from which the data were collected was normally distributed. ANOVA is a useful statistical technique that shows the mean difference for more than two groups (Pallant, 2007). The Post hoc particularly Turkey's Honestly Significant Different (HSD) was used for multiple comparisons. The test is designed to make all pair wise comparisons while maintaining the experiment wise error rate at the pre-established level (Pallant, 2007). In this study, villages are considered as independent groups. SPSS version 20 was used to generate descriptive statistics of respondents' socio-economic and demographic characteristics. SPSS was also used to compute percentage distribution for various variables.

2.4. Results and Discussion

2.4.1 Respondents' socio-economic and demographic characteristics

Respondents' socio-economic and demographic characteristics are presented in Table 2.3.

Table 2.3: Respondents' socio-economic and demographic characteristics

Sex	Welela	Kichiwa	Tagamenda	Kidegembye	Total
Male	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Female	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Respondent's age					
18-39	30(12.0)	17(6.8)	21(8.4)	24(9.6)	92(36.8)
40-59	41(16.4)	29(11.6)	43(17.2)	28(11.2)	141(56.4)
60 above	7 (2.8)	0(0.0)	4(1.6)	6(2.4)	17(6.8)
Relationship to the household head					
Head of household	38(15.2)	27(10.8)	43(17.2)	35(14.0)	143(57.2)
Spouse	32(12.8)	15(6.0)	22(8.8)	20(8.0)	89(35.6)
Daughter	2(0.8)	0(0.0)	0(0.0)	0(0.0)	2(0.8)
Son	6(7.7)	4(8.7)	3(4.4)	3(5.2)	16(6.4)
Respondents' marital status					
Married	57(22.8)	30(12.0)	45(18.0)	40(16.0)	172(68.8)
Single	4(1.6)	2(0.8)	1(0.4)	1(0.4)	8(3.2)
Divorced	2(0.8)	0(0.0)	0(0.0)	1(0.4)	3(1.2)
Widowed/widower	15(6.0)	14(5.6)	22(8.8)	16(6.4)	67(26.8)
Main source of income of the household					
Farming	65(26.0)	38(15.2)	56(22.4)	48(19.2)	207(82.8)
Business	11 (4.4)	8(3.2)	12(4.8)	10(4.0)	41(16.4)
Salary	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Casual labour	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Education level					
No formal education	3(1.2)	0(0.0)	3 (1.2)	2(0.8)	8(3.2)
Primary education	42(16.8)	33(13.2)	58(23.2)	37(14.8)	170(68.0)
Secondary school	21(8.4)	9(3.6)	5(2.0)	16(6.4)	51(20.4)
Tertiary education	12(4.8)	4(1.6)	2(0.8)	3(1.2)	21(8.4)
Respondents' Main occupations					
Farming	70(28.0)	44(17.6)	65(26.0)	56(22.4)	235(94.0)

Small scale business	8(3.2)	2(0.8)	3(1.2)	2(0.8)	14(5.6)
Formal employment	0(0.0)	0(0.0)	0(0.0)	1(0.4)	1(0.4)

Note: *The numbers in brackets are per cent*

The results showed that 50% of the respondents were females. It was intentional to involve 50% females in the sample because they are actors in groundwater management due to their roles. In relation to age groups, 56.4% were between 40-59 years old. This indicates that the study area had potential labour force of young adults who are essential for economic activities. The results also show that 94% of the respondents depended on farming as the main source of income. The rest depended on small scale businesses like tailoring, bricks making, and crop selling. This implies that livelihood of the majority of the respondents depended on farming. Welela, Kichiwa and Tagamenda villages mainly produced food crops whereas Kidegembye produced cash crops such as tea and trees for timber production. According to URT (2018), agriculture provides employment to 66.3% of Tanzanians.With regard to the respondents' education level, 68% of the respondents had primary education whereas 20.4% had secondary level of education (Table 2.3). This implies that the majority had acquired the basic education.

Table 2.4 shows respondents' age, household size, total number of years a household resided in the village and household annual income. Based on that table, the mean age of the respondents was 43 years. This implies that majority of the respondents were adults. Furthermore, the results show that the mean number of persons per household was 5.6. This number was above 4.9 persons reported at the national level (United Nations World Food Programme and World Bank, 2013) as well as 4.2 persons reported in Njombe District (URT, 2016b). With regard to the total number of years in which respondents

resided in the village; the results show that the mean number was 41 years. This suggests that the majority had enough experience on groundwater management in the study area.

Table 2.4: Some socio-demographic characteristics

Socio-demographic characteristics	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	23	78	43.0	11.8
Years of schooling of the respondent	0	13	8.1	2.5
Total number of the people in the household	3	9	5.6	1.3
Total number of years residing in the village	12	60	41.0	10.8
Annual income of the household from the main source of income	225 000	13 700 000	3 468 982	3 181 766.7

2.4.2 Groundwater governance principles guiding groundwater governance

Findings on the groundwater governance principles and the approximate distance in metres from the respondents' households to groundwater points that were investigated in this study are presented in Table 2.5 and Table 2.6 respectively. About participation, 73% of the groundwater users participated to formulate by- laws in their localities. In some cases, the communities were represented by COWSOs in making by-laws. In addition, groundwater users showed a sense of ownership of groundwater and allocating groundwater points. However, 56% of the groundwater users did not participate in budgeting resources for groundwater management. This connotes that majority of the groundwater users participated in groundwater governance particularly to formulate by-laws and allocating groundwater points. This is contrary to Comte *et al*. (2016) and Masifia and Sena (2017) who argue that water projects in Tanzania experiences poor community participation in decision making.

Table 2.5: Respondents' responses on practice of governance principles (n=250)

Governance principles	Statements	Disagree	Neutral	Agree
Participation	Owning properties for groundwater management	50(20.0)	30(12.0)	170(68.0)
	Budgeting resources for groundwater management	140(56.0)	96(38.4)	14(5.6)
	Allocating groundwater source points	17(6.8)	50(20.0)	164(65.6)
	Contributing resources for groundwater management	49(19.6)	105(42.0)	96(38.4)
	Formulating by-laws for groundwater management	66(26.4)	20(8.0)	183(73.2)
Accountability	Giving accounting reports	160(64.0)	40(16.0)	50(20.0)
	Accepting challenges related to groundwater management	55(22.0)	154(61.6)	41(16.4)
	Accepting challenges from groundwater users	183(73.2)	20(8.0)	47(18.8)
	Sharing lessons learned on groundwater management	194(77.6)	31(12.4)	25(10.0)
	Explaining openly the rationale for various decisions made	59(23.6)	154(61.6)	37(14.8)
	Discussing the accounting reports	215(86.0)	3(1.2)	32(12.8)
Transparency	Presenting the agenda of groundwater management in meetings	130(52.0)	50(20.0)	70(28.0)
	Providing financial statements	177(70.8)	20(8.0)	53(21.2)
	Allowing criticism from groundwater users	213(85.2)	21(8.4)	16(6.4)
	Giving or accepting apologies when matters have gone wrong	210(84.0)	18(7.2)	22(8.8)
	Sharing information from various governance structures	207(82.8)	18(7.2)	25(10.0)
	Knowing all source of funds if any	217(86.8)	8(3.2)	25(10.0)
Equitability	Treating all groundwater users with respect and dignity	76(30.4)	13(5.2)	161(64.4)
	Both men and women have opportunity of being leaders	87(30.8)	26(10.4)	137(58.8)
	Encouraging groundwater users to contribute resources	204(81.6)	16(6.4)	30(12.0)
	Witnessing fair source points allocation	88(35.2)	22(8.8)	140(56.0)
	Involving all people on groundwater management regardless their income differences	54(21.6)	13(5.2)	183(73.2)
	Involving all people on groundwater management regardless their age differences	100(40.0)	40(16.0)	110(44.0)
Efficiency	Groundwater points are well protected against pollution	101(40.4)	15 (6.0)	134(53.6)
	Mutual respect among groundwater users to access water	88(35.2)	5 (2.0)	157(62.8)
	Groundwater points is nearly allocated at the household	91(36.4)	50(20.0)	109(43.6)
	Availability of groundwater	76(30.4)	19(7.6)	155(62.0)
Rule of law	Paying the number of contributions as agreed	130(52.0)	60(24.0)	60(24.0)
	Prohibiting all socio activities around groundwater points	60(24.0)	66(26.4)	124(49.6)
	Giving sanctions to all people who breached water rules regardless their social or economic status	72(28.8)	128(51.2)	50(20.0)
	Groundwater management focus on issues not on a person	105(42.0)	100(40.0)	45(18.0)
Responsiveness	Timely disseminating the information	191(76.4)	37(14.8)	20(8.0)
	Repairing groundwater infrastructures timely when they have to be repaired	160(64.0)	46(18.4)	44(17.6)
	Contributing timely the resources for groundwater management when is needed	141(56.4)	44(17.6)	65(26.0)
	Groundwater users receive timely groundwater related financial reports	166(66.4)	47(18.8)	37(14.8)
Collaboration	Addressing groundwater management challenges	195(78.0)	15(6.0)	40(16.0)
	Creating community awareness on groundwater management	211(84.4)	20(8.0)	19(7.6)
	Encouraging groundwater users to participate on groundwater management	176(70.4)	29(11.6)	45(18.0)

Enforcing various by- laws of groundwater management	180(72.0)	40(16.0)	30(12.0)

Note: *The numbers in brackets are per cents*

The contradiction of the results in this study and those of Comte *et al*. (2016) and Masifia and Sena (2017) is explained by the presence of COWSOs in Njombe District that represent the communities in by-laws formulation for groundwater governance. With regard to accountability, the results showed that five out of six statements of the accountability principle were poorly practiced (Table 2.5).

Respondents (above 50%) showed that financial reports were not shared with groundwater users; COWSOs were not willing to accept challenges from groundwater users; COWSOs did not share lessons learned and sharing financial reports on groundwater management (Table 2.5). Quantitative results were in line with COWSO's key informants' results in Kichiwa such that COWSOs did not collect water charges from groundwater users and therefore there was no need of preparing financial reports to share with other actors. This is explained by the reluctance of groundwater users to pay water charges. The key informant from RUWASA argued that the problem of not paying water charges persisted because of less commitment of COWSOs to create awareness of the importance of paying water charges among groundwater users. The results are in line with that of Damania *et al*. (2017), Katomero (2017), Masifia and Sena (2017) and Nganyanyuka (2017) who showed poor accountability among water governance actors in developing countries like Tanzania.

With regard to transparency, all statements were poorly practiced. For instance, 86.8% and 85.2% of the respondents were not aware about sources of funds that were vested for groundwater development and they were not free to criticise water governance actors, respectively (Table 2.5). Other aspects that were poorly practised include transparency

since groundwater users did not discuss groundwater agenda during village assemblies; providing financial reports of the collected funds; giving or accepting apologies when groundwater matters went wrong; and sharing communication and information from various groundwater governance actors (Table 2.5). This confirms poor transparency practised by COWSOs. The results concur with those by Comte *et al*. (2016), Kabote and Gudaga (2018) and Mandara *et al*. (2013) who found that groundwater governance in Tanzania faces poor transparency of governance actors especially on financial matters.

On equitability, which is a state of providing equal opportunity to the communities to access groundwater information, 73.2% of the respondents were involved in groundwater matters regardless of their income differences, and 64.4% of the respondents agreed that all groundwater users were treated with respect and dignity to access groundwater points (Table 2.5). Other statements which were well practised include opportunity for both men and women to be COWSO leaders and fairly allocation of groundwater points (Table 2.5). This implies that equitability was effectively practised in the study area. The results are not in agreement with those of Maranda (2014), Nganyanyuka (2017) and Sudi *et al*. (2019) who argue unequal women leaders in water governance structures like COWSOs.

On efficiency, all statements were in agreement suggesting efficiency in terms of protecting groundwater points against pollution, accessibility of water to groundwater users and availability of groundwater (Table 2.5). Using ANOVA, the overall mean distance from households to groundwater points was 399 metres (Table 2.6). This indicates that groundwater resource in the study area was accessible. The results of this study are in line with those of Gudaga *et al*. (2018) whereby it was reported that groundwater resource had an advantage of being nearly accessible from home.

Table 2.6: Approximate distance in metres from the respondents' households to the groundwater points

Villages	n	Mean	Std. Deviation	F	P-Value
Welela	78	380.13	181.140		
Kichiwa	46	430.83	199.921		
Tagamenda	68	431.43	200.230	2.580	.054
Kidegembye	58	355.17	159.365		
Total	**250**	**399.39**			

The difference in distance from households to the groundwater points between the villages was statistically significant at 5% level of significance. The lowest mean distance from households to the groundwater points was about 355 metres in Kidegembye while the highest mean distance was about 431 metres in Tagamenda.

Using the Multiple Comparisons analysis (Table 2.7), the results showed that there was a significant difference in terms of distance in metres from the households of groundwater users to the groundwater points between villages. The significant difference was between Welela and Tagamenda villages ($p = 0.000$) and Kidegembye and Tagamenda villages ($p = 0.001$). The differences are mainly associated with the total number of groundwater points in villages. Some villages like Kidegembye and Welela had high number of groundwater points than the Kichiwa and Tagamenda villages (Table 2.2). For instance, Kidegembye village had six groundwater points with 154 households while Tagamenda village had four groundwater points with 186 households. This justifies the mean distance from the households of groundwater users to the groundwater points (Table 2.6) in relation to a total number of groundwater pints. Gudaga *et al*. (2018) argued that proper distribution of groundwater points in a given population is imperative to enhance water accessibility.

Table 2.7: Compared mean difference on the distance from groundwater users' households to groundwater points between villages (n=250)

Compared villages		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Welela	Tagamenda	.50354	.07777	.000	.3504	.6567
	Kidegembye	.16945	.08413	.163	.0234	.3155
	Kichiwa	.30085	.08397	.090	.1355	.4662
	Welela	.33408	.07991	.000	.1767	.4915
Tagamenda	Kidegembye	-.16945	.07413	.001	-.3155	-.0234
	Kichiwa	.13140	.08595	.128	-.0379	.3007
	Welela	-.50354	.07777	.170	-.6567	-.3504
Kidegembye	Tagamenda	-.33408	.07991	.001	-.4915	-.1767
	Kichiwa	-.20268	.08911	.064	-.3782	-.0272
	Welela	-.30085	.08397	.169	-.4662	-.1355
Kichiwa	Tagamenda	-.13140	.08595	.128	-.3007	.0379
	Kidegembye	.20268	.08911	.084	.0272	.3782

About the rule of law, 49.6 % of the respondents showed that COWSOs had a by-law which prohibited households from undertaking socio-economic activities around groundwater points (Table 2.5). Quantitative results were in line with information from COWSOs and villages leadership. The aim of this restriction was to keep groundwater points safe and free from pollution. To implement the by-law, COWSOs imposed a fine for those who breached it. The amount of the fine varied between TZS 20 000 and 50 000. Scholars including Comte *et al*. (2016), Kabogo *et al.* (2017) and Pantaleo *et al.* (2019) show that most of the groundwater points in Tanzania are not well protected putting groundwater at a risk of contamination or damage of the infrastructures.

In terms of responsiveness, 76.4% and 66.4% of the respondents reported that COWSOs did not disseminate information timely on groundwater management and financial issues, respectively (Table 2.5). Other aspects of responsiveness that were poorly practised included late repairing of groundwater infrastructures and contributing timely funds for groundwater when needed. The issue of COWSOs poor responsiveness was also reported

by the District Water Department Officer as follows: "...*COWSOs are not knowledgeable on groundwater governance."* This implies limited knowledge and skills of dealing with governance issues contributed to COWSOs poor responsiveness.

Knowing that COWSOs faces challenges including poor responsiveness, the Water Supply and Sanitation Act No.5, of 2019 has transformed them into Community Based Water Supply Organizations (CBWSOs) to improve groundwater governance in the country (Fierro *et al*., 2017). Some of aspects that have been considered in the proposed CBWSOs include: involvement of professionals like water technician and an accountant who should be a technician level three in accountancy. In addition, CBWSOs will be owned by the village government and communities. This is different from COWSOs that were mainly owned by the communities (URT, 2019a). Unquestionably, the involvement of professionals in CBWSOs is likely to improve groundwater governance particularly responsiveness in addressing groundwater management.

About collaboration, 84.4% of the respondents reported that, COWSOs did not collaborate with Village Councils in creating community awareness of groundwater governance (Table 2.5). Other areas where groundwater governance actors did not collaborate include: addressing groundwater challenges, encouraging groundwater users to participate in groundwater management and enforcing by-laws for groundwater governance (Table 2.5). The results are in line with those of Kabote and Gudaga (2018), Masifia and Sena (2017). This negatively affects opportunities such as sharing resources, experience, and knowledge about groundwater governance.

2.5 Conclusions and Recommendations

The results showed that most of the governance principles were poorly practised while a few were well practised. Three governance principles that were well practised were participation, equitability and efficiency. Transparency, accountability, rule of law, responsiveness, and collaboration were poorly practised. It is concluded that groundwater governance actors did not practise effectively the governance principles. Based on the arguments of Good Governance Theory, the study asserts that the study area had poor groundwater governance hence it can affect negatively groundwater management in the area.

Based on that conclusion, governance actors especially COWSOs should effectively practise governance principles particularly transparency, collaboration, rule of law, responsiveness and collaboration. This will motivate groundwater users and other governance actors to engage seriously in groundwater management. In addition, governance actors should establish good relationships between them and proper documentation of records related to groundwater management. This will foster mutual sharing of experience and opportunities in addressing groundwater governance and management.

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CHAPTER THREE

3.0 Groundwater Governance Levels in Njombe District, Tanzania

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3.1 Abstract

Despite existence of institutional and legal framework for water management and governance in Tanzania, literature indicates lack access to improved drinking water sources by 40% of the population and high failure rate of water points. At the same time, there is paucity of information about groundwater governance in Njombe. The general objective of this paper was to establish groundwater governance levels in the study area by adopting governance principles. The specific objectives of the paper were: To quantify the overall level of groundwater governance in the study area and to compare the respondents' responses by villages and by sex. The paper was guided by the following question: What is the extent of groundwater governance in the study area? The paper also adopted cross-sectional research design, and a random sample of 250 respondents was involved. The *Kruskal Wallis H Test* and the *Mann Whitney U Test* were used to compare responses between different groups while qualitative data were subjected to the content analysis. Overall, groundwater governance was low, and this was reported by 53.2% of the respondents. Based on the *Kruskal Wallis H test* results, the level of groundwater

governance was significantly low and differed statistically at 5% between localities and by governance principles mainly participation, equitability, efficiency, rule of law and responsiveness. The *Mann Whitney U test* showed statistically significant difference in respondents' responses between male and female responses on the level of participation ($p = 0.002$), efficiency ($p = 0.045$) and rule of law ($p = 0.015$). Female respondents showed higher levels of governance principles than male respondents. The study concludes that the levels of practicing governance differed by governance principles and locality. This suggests the need to measure each of the governance principles separately when attempting to measure the overall level of groundwater governance. Since the overall level of groundwater governance was low, it is recommended that groundwater governance actors should practise all eight (8) governance principles effectively.

Keywords: Groundwater governance, Groundwater management, Njombe District, Tanzania.

3.2 Introduction

The question of access to sustainable water service is not only one of the human rights, but also one of the development priorities in Tanzania and the world at large. However, access to water supply is not that much improved at all levels calling for, among other things, strengthening management and governance of the available water sources. For instance, more than four billion, equivalent to about 66.7%, of the global population lived under severe water scarcity conditions for at least one month in a year by 2016. This proportion is expected to decrease such that by 2050 at least 57% of the global population will be living under severe water scarcity conditions at least one month per year (Mekonnen and Hoeksta, 2016). According to the World Bank (2018), about 315 million

people in Sub Saharan Africa (SSA) have no access to clean and safe drinking water. The same report shows that the problem is more serious in rural than urban areas. Even though, there are issues of water quality, affordability and reliability of drinking water in urban areas. Therefore, poor access to clean and safe drinking water is a widespread problem in the world.

In Tanzania, a report published by the World Bank (2018) showed that 40% out of 55.6 million people lacked access to improved drinking water sources by 2016. The same report succinctly indicated high failure rate of 20% of water points in the first year of operation in the country (World Bank, 2018), implying poor sustainability, governance and/ or poor management of water facilities. The problem is more serious in rural areas where the population that lacks access to improved drinking water sources ranges from 52% to 54% compared to 13% in urban areas (World Bank, 2018). The major water sources in rural Tanzania are traditional borehole wells, and in other areas constructed groundwater wells. Literature including Mekonnen and Hoeksta (2016) shows poor groundwater quality at all levels with minimal information about groundwater governance. With that this study quantifies groundwater governance using governance principles. The fundamental research question guiding this study is ‘what is the extent of groundwater governance in the study area and how groundwater governance levels differ by local localities?’

There is no common definition of water governance in the literature. Some scholars like Stefano *et al.* (2014) define it as a process whereby public officials acquire and practice authority on behalf of the public in developing, utilizing and protecting water resource. Others including Kabote and John (2017) define this concept boldly based on structures

and institutions: first, as a process whereby governance structures such as COWSOs, district councils, village governments, water users' associations, village water committees and private sector operate for water management. Second, it is a process whereby institutions like water rules influence behaviour of water users, which also include governance structures. In addition, UNDP (2013) defines water governance as decisions made to manage water resource based on the particular policy setting. These definitions inform that water governance actors are public and private. There is an indication in the literature that one cannot talk about governance without considering about governance principles that include: transparency, accountability, rule of law, responsiveness, collaboration, equitability, and efficiency (UNDP, 1997; IFAD, 1999; Burns *et al*., 2004; Hoekstra, 2006; Lockwood *et al.,* 2010; Garduño *et al*., 2011; Zaag and Savenije, 2014; Stefano *et al.*, 2014; Tarlock, 2015).

The concept of groundwater governance is also defined differently in the literature. Some authors including Megdal *et al*. (2015) define groundwater governance as a comprehensive framework which encompasses laws, regulations and customs for utilisation of groundwater. Others like Foster *et al.* (2009) define groundwater governance as a collective action to enhance sustainable and efficient utilisation of groundwater for the benefit of the people and ecosystems in general. Furthermore, FAO (2013) adopted in this study, defines groundwater governance as managing groundwater through governance principles. However, it is important to put clear on the definition of groundwater management concept. According to Toonen (2011), the concept of groundwater management is defined as a practical social reaction with a given means or conditions to sustain water resource in a particular area. This study defines groundwater governance as the presence of groundwater institutions such as laws, regulations and customs used by

the responsible water governance structures to enhance groundwater management in the country whereas groundwater management is defined as routine activities, like protection of groundwater sources from pollution, paying water charges and protecting groundwater infrastructures from destruction among others, that are performed by groundwater users (URT, 2009).

Governance studies are increasingly being guided by Good Governance Theory. This theory was developed by the United Nations Development Program and the World Bank in the early 1990s to help developing countries attain political and socio-economic development through good governance (Ekundayo, 2017; Setyadiharja *et al*., 2017; Keping, 2018). The main argument in this theory is that developing countries can achieve political and economic development if they exercise good governance in terms of how public institutions conduct public affairs and manage public resources in a preferred way. Therefore, practice of governance principles like participation, rule of law, transparency, responsiveness, equality, collaboration, efficiency and accountability becomes imperative (UNDP, 1997; Burns *et al*, 2004; Keping, 2018). Ekundayo (2017) successfully used the Good Governance Theory to quantify political governance using governance principles in Nigeria.

This paper used governance principles stipulated in the Good Governance Theory to quantify groundwater governance in Njombe District. The study puts forward the following arguments: first, the level of groundwater governance depends on the extent to which governance structures and/ or actors practise governance principles. Secondly, poor practice of governance principles leads to low or poor groundwater governance, which definitely result into poor groundwater management. Third, as independent variables,

legal governance structures like Community Owned Water Supply Organizations (COWSOs) should adequately practise governance principles for good governance and sound groundwater management. This leads to good and/ or high groundwater governance level as shown in Fig. 3.1.

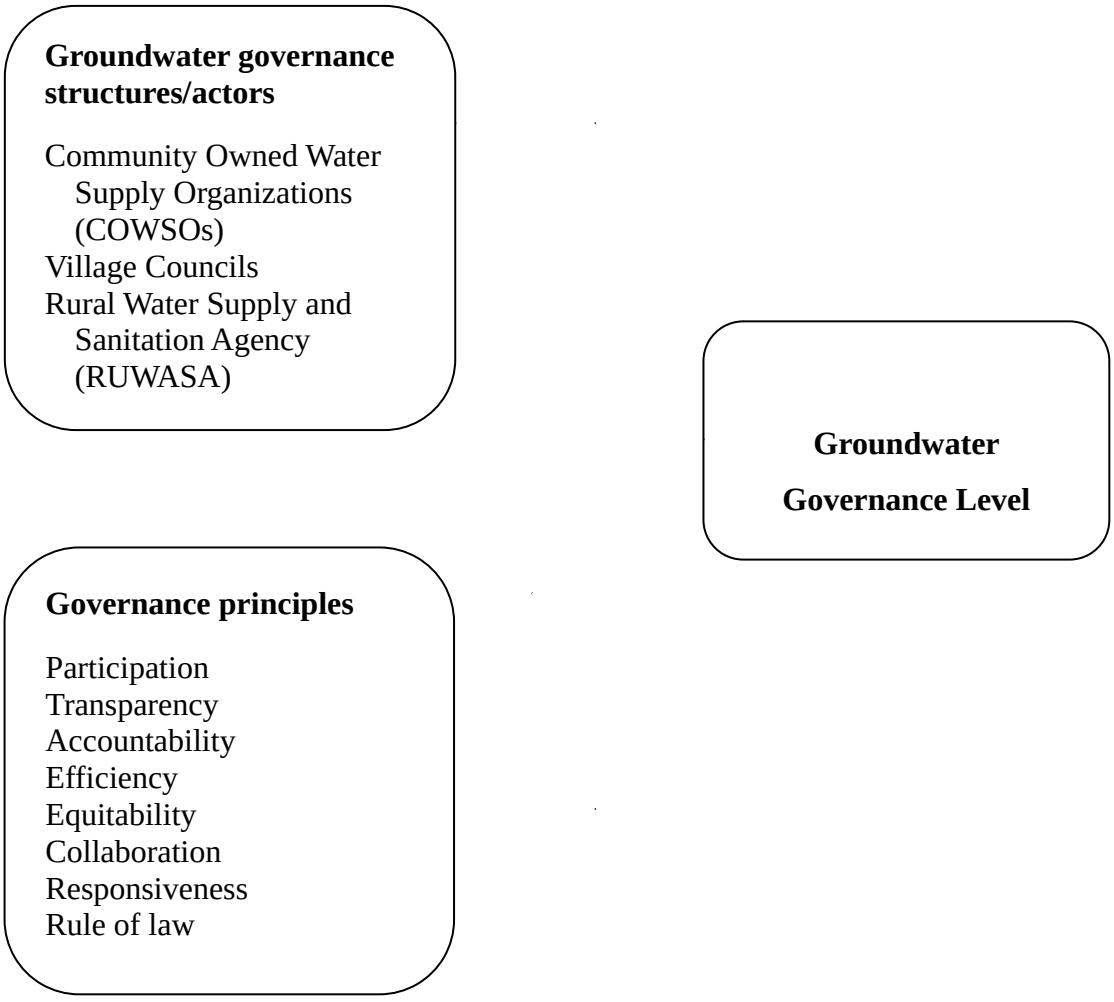

Figure 3.1: Conceptual framework for groundwater governance levels

Source: Adapted from UNDP (1997); Ekundayo (2017); Keping (2018); Abrha (2016)

The overarching research question was: what is the extent of groundwater governance in the study area?

Operational definitions for different governance principles are shown in Table 3.1.

Table 3.1: Operational definitions of governance principles

Variable	Operational definition	Sources
Participation	Offering a household an opportunity for making decision, owning, planning and budgeting resources	UNDP (1997); Burns *et al*. (2004); Lockwood *et al.* (2010)
Accountability	Is a tendency of groundwater governance actors responsible for their actions in relation to groundwater management matters	Lockwood *et al.* (2010) Zaag and Savenije (2014).
Efficiency	Refers to the availability, accessibility and protection of groundwater resource	Abrha (2016)
Transparency	Availability and accessibility of information related to groundwater governance.	Sanz *et al*. (2016); Lockwood (2010)
Equitability	Providing equal opportunity to the community regardless their socio-demographic differences	UNDP (1997); Lockwood (2010).
Collaboration	Working actively together among different actors	Graham *et al. (*2003)
Responsiveness	Reacting actively and timely on groundwater management matters.	Abrha (2016)
Rule of law	Applying clearly and uniformly water rules to all groundwater users	Zaag and Savenije, (2014); Abrha (2016)

3.3 Methodology

3.3.1 The study area

The study was conducted in Njombe District, Njombe Region (Figure 3.2), because of dependence on groundwater for domestic water supply in the district, managed by governance actors like COWSOs, Village Councils through water committees and Water Users Associations (WUAs). Data collection took place between September and November 2019.

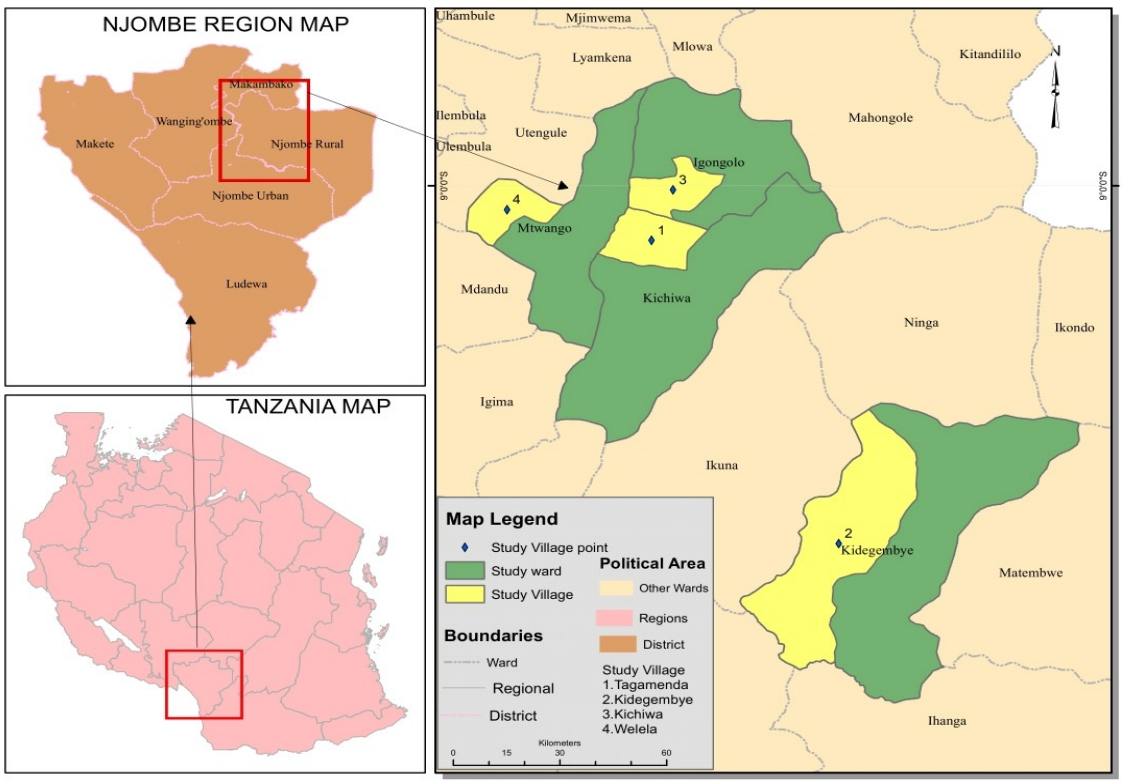

Figure 3.2: Location map of Njombe District showing the study area

According to the 2012 Population and Housing Census, the district had a population of 309 797 persons (Tanzania National Bureau of Statistics, 2012). The report shows that the average annual population growth rate in the district was 1.6%. Using population projection model recommended by George *et al*. (2004) and Carmichael (2016), the district population is projected using the follow equation:

$$P_p = P_t + (1 + r)n \quad \text{..... (1)}$$

Where P_p = population in the target year; P_t = population in the launch year; r = annual population growth rate, and n =difference between censured year, which is 2012 in this case. Thus, substituting the values into equation 1, the population in Njombe District is expected to be 349 453 by the year 2020. Population information is important for proper planning of social services like groundwater.

The district has an average annual rainfall of 1 500 mm (Madzengo, 2014), and it is characterised by unimodal climate, with a single rainy season that extends from November to April. The monthly temperature varies between 8°C and 24.7°C (Mtongori *et al*., 2015). The major water sources in the District are shallow wells. Others are piped water, springs, rivers and rain water harvesting (Tanzania National Bureau of Statistics, 2012). According to the Water Sector Status Report 2015-2020, it is reported that 80% of the population in Njombe District have access to clean and safe water (URT, 2019a), and water projects are mainly managed at a village level with actors like COWSOs, Village Water Committees, and Water Users' Associations (WUAs). By 2016, the District had 65 water projects for water supply services whereas 35 of the projects were groundwater shallow wells with less than 50 m deep (URT, 2016a). This implies that groundwater constitutes 53.8% of all water projects in the District. However, there are governance issues like pollution, and unsustainability of groundwater infrastructures (Arduino *et al*., 2012; Holtslag and Mgina, 2016; URT, 2016a; 2016b).

3.3.2 Research design, sampling procedures and sample size

This study adopted cross-sectional research design that mixed quantitative and qualitative approaches in order to triangulate and complement the approaches (Creswell, 2014). The design was useful because the study collected data from one point in time without repetition from the sample population (Bailey, 1998; Kesmodel, 2018). Two divisions namely Makambako and Lupembe were selected using a purposive sampling procedure. Four wards of Mtwango, Kichiwa, Igongolo and Kidegembye were purposively selected in the divisions. The divisions and wards were selected based on availability of groundwater points as shown in Table 3.2. Kothari (2006) recommends the use of purposive sampling technique when the research focuses directly on the intended area of

study. The study used officials from Rural Water Supply and Sanitation Agency (RUWASA) to obtain information about presence of groundwater points in the wards. One village from each ward, making four villages in total, was randomly selected.

Table 3.2: Number of sampled households and groundwater points in the selected study villages

Village	Groundwater sources/points/shallow wells	Total households(N)	Sample households (n)	Total Per cent (%)
Welela	6	210	78	31
Tagamenda	4	186	69	28
Kidegembye	6	154	58	23
Kichiwa	5	120	45	18
Total	**22**	**670**	**250**	**100**

Simple random sampling was used to select household respondents whereas the head of a household and or a spouse responded to the questions. The plan was to interview equal number of males and females because they are both beneficiaries but definitely with different perspectives of groundwater governance because of different gender roles. When we interviewed a household head the next responded had to be a spouse, and vice versa, until the required sample size was reached. This gave an equal number of male and female respondents. The Yamane (1967) formula was used to estimate the total sample size because the population size was finite (Louangrath and Sutanapong, 2019). The Yamane formula is expressed as:

$$n = \frac{N}{1+N(e)^2} \quad \text{..... (2)}$$

Where:

n = the sample size;

N = the population size, and

e = the level of precision.

Substituting the 670 total households and 0.05 level of precision into equation 2, we get the total sample size equals to 250. That is:

$$\frac{670}{1 + 670(0.0)2} \text{n} = 250.47 \approx 250$$

A proportionate sampling was employed, using the following formula, in order to ensure that the number of sampled households in each village was proportional to the total number of households (Kothari, 2006).

$$\text{a} = \frac{n}{N*b} \text{.....} \quad (3)$$

Where:

a = sample size for each village

n = total number of sampled households for 4 villages

N = target households for 4 villages, and

b = target households in each village

3.3.3 Data collection methods and tools

A household survey guided by a structured questionnaire was used to collect quantitative data. The questionnaire helped to obtain data related to the respondents' socio-economic and demographic characteristics, and quantified governance principles. The questionnaire was pretested to 15 respondents in a village that was not included in the sample. According to Sheatsley (1983) cited by Zukerburg *et al.* (1994), 12-25 cases in pretesting are sufficient to reveal major weaknesses of a research tool. The outputs of pretesting were used to refine questions in the questionnaire.

Focus Group Discussions (FGDs) and key informant interviews were deployed to collect qualitative data. One FGD was conducted in each village making a total of four FGDs. One FGDs comprised seven to nine participants particularly groundwater users. The proportion of women FGDs participants ranged from 4 to 6 per group. The groups included males and females because according to URT (2002), both are responsible for groundwater management. Thus, mixed groups helped to obtain views of both males and females. FGDs are useful to generate information through discussion on the topic of interest (Creswell, 2014). A total of 9 key informants, mainly leaders, from Community Owned Water Supply Organizations (COWSOs), Village Government Authorities (VGAs) and Rural Water Supply and Sanitation Agency (RUWASA) were involved. Both FGDs and key informant interviews were guided by a checklist of items.

3.3.4 Measurement of groundwater governance levels

A Summated Index Scale (SIS) with five points was used to measure the level of groundwater governance. The study quantified governance principles by assigning points to each phrase shown in Table 3.3; for strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points) and strongly disagree (1 point).

Table 3.3: Statements used to quantify governance principles

Governance principle	Phrases
Participation	(i) Owning properties for groundwater management (ii) Budgeting resources for groundwater management (iii) Allocating groundwater source points (iv) Contributing resources for groundwater management (v) Formulating by-laws for groundwater management
Accountability	(i) Giving accounting reports (ii) Accepting challenges related to groundwater management (iii) Accepting challenges from groundwater users (iv) Sharing lessons learned on groundwater management (v) Explaining openly the rationale for various decisions made (vi) Discussing the accounting reports
Transparency	(i) Presenting the agenda of groundwater management in meetings (ii) Providing financial reports (iii) Allowing criticism from groundwater users (iv) Giving or accepting apologies when matters have gone wrong (v) Sharing information from various governance structures (vi) Knowing all source of funds if any
Equitability	(i) Treating all groundwater users with respect and dignity (ii) Both men and women have opportunity of being leaders (iii) Encouraging groundwater users to contribute resources (iv) Witnessing fair source points allocation (v) Involving all people on groundwater management regardless their income differences (vi) Involving all people on groundwater management regardless their age differences
Efficiency	(i) Protecting groundwater points against pollution (ii) Mutual respect among groundwater users to access water (iii) Groundwater points are nearly allocated at the household (iv) Availability of groundwater
Rule of law	(i) Paying the amount of contributions as agreed (ii) Prohibiting socio-economic activities around groundwater points (iii) Giving sanctions to all people who breached water rules regardless their social or economic status (iv) Groundwater management focus on issues not on a person
Responsiveness	(i) Timely disseminating the information (ii) Repairing groundwater infrastructures timely when they have to be repaired (iii) Contributing timely the resources for groundwater management when is needed (iv) Groundwater users receive timely groundwater related financial reports
Collaboration	(i) Addressing groundwater management challenges (ii) Creating community awareness on groundwater management (iii) Encouraging groundwater users to participate on groundwater management (iv) Enforcing various by- laws of groundwater management

The equation for the Summated Index Scale is shown as follows:

$L_{i,s,j} = \sum_{i,s,j} R$ .....(4)

Where:

R = scales in form of 1, 2, 3, 4, and 5

i = governance principles: participation, accountability, transparency, efficiency, rule of law, equitability, responsiveness, and collaboration

j = number of respondents (250)

s= number of statements per each governance principle

$L_{i,s,j}$ = Total score

Since the scale was generated using ordinal data, median was used as a cut-off point to establish the levels of groundwater governance and was calculated using the following equation:

Median = $\frac{(n+1)}{2}$ th value. .....(5)

Whereas:

n = total number of data set

There were different median values for each governance principle. Thus, the total scores of all statements less than median ($L_{i,s,j}$ < median), represents low or poor governance principle. The total scores of all statements equals to median ($L_{i,s,j}$ = median), implies medium implementation governance principle. In addition, the total scores greater than median ($L_{i,s,j}$ > median), indicates high or good governance. Median is a useful measure

of central tendency for ordinal data because it is not sensitive to outliers (Nicholas, 1999; Godino, 2002).

The median differed by governance principles because of different number of phrases. There were five statements for participation, and six for accountability, transparency and equitability. The principles of efficiency, rule of law, responsiveness and collaboration had four statements. Using equation five, the median for participation was 15 while the median for accountability, transparency and equitability was 18. In addition, the median for efficiency, rule of law, responsiveness and collaboration was 12. The Cronbach's Alpha was used to measure inter-item consistency and reliability of the scale. The equation to calculate the Cronbanch's alpha value is given as follows:

$$a = \frac{K}{K - 1}\left(1 - \sum \frac{V_i}{V_t}\right) \quad \text{.....(6)}$$

Where:

α = Alpha

K = Number of questions

V_i= Variance of scores on each question

V_t= Total variance of overall scores (Not percentages on the entire test)

The result of the Cronbanch's Alpha value was 0.8 indicating that the scale was reliable. A Cronbanch's Alpha value less than 0.6 is considered to be poor while those between 0.7 and 1.0 are considered good (Pallant, 2007).

3.3.5 Data analysis

Qualitative data collected through key informant interviews and FGDs were analysed through content analysis by combining together similar ideas. The analysis of quantitative data was carried out through Statistical Package for the Social Sciences (IBM SPSS version 20). This helped to summarize data using frequency and percentage which simplified the description and presentation of the results. The *Kruskal Wallis H test*, a non-parametric test, was used to compare differences of the respondents' responses in the villages on the level of groundwater governance at 5% level of significance. This helped to determine whether there was significant difference on the level of groundwater governance between the villages. The study was interested to test differences between the villages because the villages through COWSOs were responsible for groundwater governance. The test statistic for the *Kruskal Wallis H test* was calculated as follows:

$$H = \frac{12}{N(N+1)}\left(\sum \frac{R_i}{n_i}\right) - 3(N+1) \quad \text{.....(7)}$$

Where:

H = Kruskal-Wallis H statistic

N = Sample size for all groups

n_i= Size of an independent sample within group i

R_i= Sum of the ranks for the i^{th} sample

The study compared differences in responses between males and females because both of them are beneficiaries of groundwater though with different gender roles regarding collection of water for domestic use (Varady *et al*., 2016). This was done by using the *Mann Whitney-U test* because male and female are two independent groups. The *Mann*

Whitney-U test is a non-parametric test that compares groups or conditions regardless the assumption that values are normally distributed. In this case, the samples should be independent and random, variables should be measured as continuous units and the level of measurement should be ordinal. If the sum of rankings from one sample differs from the sum ranking of the other sample, it shows difference in the population medians (Kilima *et al*., 2014). The U statistic for the *Mann Whitney U test* was calculated as follows:

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - \sum R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2-1)}{2} - \sum R_2$$

Where:

n_1 and n_2 are the two sample sizes

$\sum R_1$ and $\sum R_2$ are the sum of ranks for samples 1 and 2, respectively

3.4 Results and Discussion

3.4.1 Respondents' socio-economic and demographic characteristics

Table 3.4 presents the respondents' socio-economic and demographic characteristics. The results showed that 50% of the respondents were males by design. In addition, 57.2% were household heads. With regard to age groups, 56.4% were between 40-59 years old. This implies that the study area had a potential labour force of young adults important for socio-economic development.

The results also showed that 94 % of the respondents depended on farming activities for the livelihood. The rest depended on small scale businesses such as tailoring, bricks making, and crop selling (Table 3.4). The results correspond with the 2012 Population and

Housing Census whereby it was reported that 92.5% of Njombe District dwellers are farmers who grow maize, beans, sunflower, tea, tomato, potatoes, and fruits (URT, 2016b).

With regard to the respondents' education level, 68% of the respondents had primary education whereas 20.4% had secondary level of education. This implies that the majority had acquired basic education necessary for life skills. The respondents' age, household size, total number of years a household resided in the villages and household annual income are shown in Table 3.5. The mean age of the respondents was 43 years. This implies that majority of the respondents were adults who can participate in socio-economic activities important for livelihoods.

Table 3.4: Socio-economic and demographic characteristics (n=250)

Sex	**Welela**	**Kichiwa**	**Tagamenda**	**Kidegembye**	**Total**
Male	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Female	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Respondents age					
18-39	30(12.0)	17(6.8)	21(8.4)	24(9.6)	92(36.8)
40-59	41(16.4)	29(11.6)	43(17.2)	28(11.2)	141(56.4)
60 above	7 (2.8)	0(0.0)	4(1.6)	6(2.4)	17(6.8)
Relationship to the household head					
Head of household	38(15.2)	27(10.8)	43(17.2)	35(14.0)	143(57.2)
Spouse	32(12.8)	15(6.0)	22(8.8)	20(8.0)	89(35.6)
Daughter	2(0.8)	0(0.0)	0(0.0)	0(0.0)	2(0.8)
Son	6(7.7)	4(8.7)	3(4.4)	3(5.2)	16(6.4)
Respondents' marital status					
Married	57(22.8)	30(12.0)	45(18.0)	40(16.0)	172(68.8)
Single	4(1.6)	2(0.8)	1(0.4)	1(0.4)	8(3.2)

Divorced	2(0.8)	0(0.0)	0(0.0)	1(0.4)	3(1.2)
Widowed/widower	15(6.0)	14(5.6)	22(8.8)	16(6.4)	67(26.8)
Main source of income of the household					
Farming	65(26.0)	38(15.2)	56(22.4)	48(19.2)	207(82.8)
Business	11 (4.4)	8(3.2)	12(4.8)	10(4.0)	41(16.4)
Salary	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Casual labour	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Education level					
No formal education	3(1.2)	0(0.0)	3 (1.2)	2(0.8)	8(3.2)
Primary education	42(16.8)	33(13.2)	58(23.2)	37(14.8)	170(68.0)
Secondary school	21(8.4)	9(3.6)	5(2.0)	16(6.4)	51(20.4)
Tertiary education	12(4.8)	4(1.6)	2(0.8)	3(1.2)	21(8.4)
Respondents' Main occupations					
Farming	70(28.0)	44(17.6)	65(26.0)	56(22.4)	235(94.0)
Small scale business	8(3.2)	2(0.8)	3(1.2)	2(0.8)	14(5.6)
Formal employment	0(0.0)	0(0.0)	0(0.0)	1(0.4)	1(0.4)

Note*: The numbers in brackets are per cents*

Furthermore, the mean number of persons per household was 5.6. This was above 4.9 persons reported at the national level (United Nations World Food Programme and World Bank, 2013) as well as 4.2 reported in Njombe District (URT, 2016b). In relation to the total number of years in which respondents lived in the villages; the results show that the mean number was 41 years.

Table 3.5: Some demographic statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	23	78	43.0	11.8
Years of schooling of the respondent	0	13	8.1	2.5
Total number of the people in the household	3	9	5.6	1.3

Total number of years residing in the village	12	60	41.0	10.8
Annual income of the household from the main source of income	225 000	13 700 000	3 468 982	3 181 766.7

The mean annual income of the households was Tanzania Shillings (TZS) 3 468 982, equivalent to TZS 289 081 per month per household (Table 3.5). This was higher than the mean household annual income at the national level. According to URT (2016b), the mean annual income is TZS 146 000 per month per household in Tanzania. The higher household income in the study area compared to the national level is attributed to factors like intensive agricultural activities. Literature, including Mwamakimbullah (2016) and Steel and Lindert (2017), found that Njombe Region is one of the prominent areas for maize and potatoes production as well as trees plantation in Tanzania. This explains the higher household income compared to other areas in the country.

3.4.2 Levels of groundwater governance

This section presents the levels of groundwater governance in the study area. Figure 3.3 presents the overall level of groundwater governance while Table 3.8; 3.9 and 3.10 present the level difference of groundwater governance, respondents' responses on groundwater governance by villages and respondents' responses on groundwater governance by sex respectively. The Summated Index Scale showed that 53.2% of the respondents reported low groundwater governance with scores less than the median.

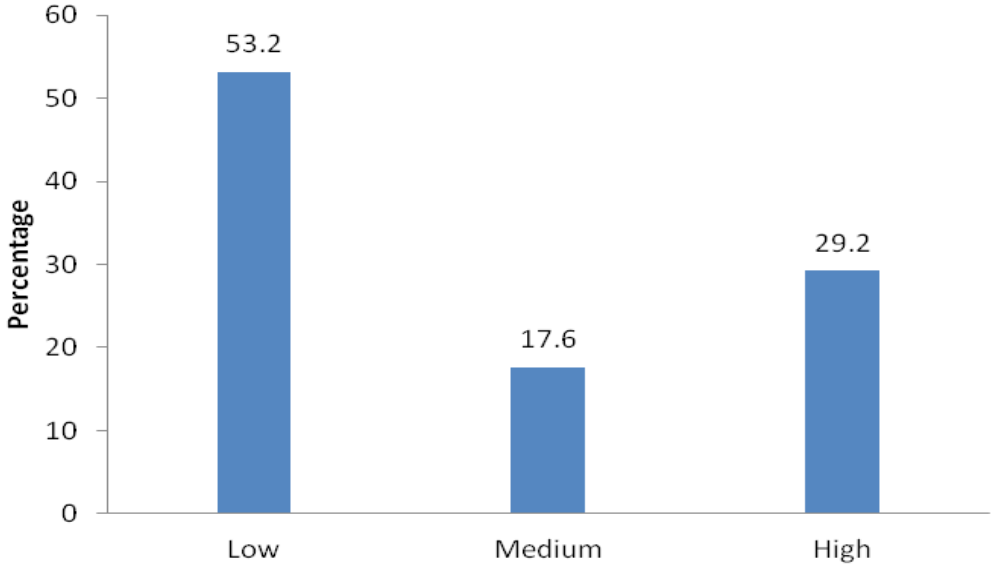

Figure 3.3: Groundwater governance levels in percentages

The results in Figure 3.3 suggest that the study area had poor groundwater governance quantified using governance principles. Possibly, poor groundwater governance constrained groundwater management in the study area. Poor groundwater governance has also been reported in Kilosa, Babati, Mbarali, Dar es Salaam and Dodoma in Tanzania (Massawe *et al.*, 2017; Gudaga *et al.*, 2018, Musa *et al.*, 2019; Pantaleo *et al.*, 2019), implying that it is a widespread problem in Tanzania. This situation is likely to accelerate groundwater pollution and non-functioning of groundwater points (Arduino *et al.*, 2012; Holtslag and Mgina, 2016; URT, 2016a; 2016b).

The levels of groundwater governance varied by governance principles (Table 3.6). On the one hand, participation, equitability and efficiency showed scores greater than the median implying high groundwater governance in terms of participation, equitability and efficiency. The scores for the rule of law rested at the median level implying medium rule of law. On the other hand, accountability, transparency, responsiveness and collaboration were low because their scores were less than the median.

Table 3.6: Levels of groundwater governance per principles in percentages

Governance Principle	Low	Medium	High
Participation	25.7	24.1	50.2
Accountability	70.7	13.8	15.5
Transparency	76.9	9.0	14.1
Equitability	40.0	8.6	51.4
Efficiency	38.9	8.9	52.2
Rule of law	30.3	48.2	21.5
Responsiveness	66.6	17.8	15.6
Collaboration	76.2	10.4	13.4

Qualitative data offered insights about reasons for the levels of governance principles in the study area. For instance, FGDs, in all villages reported that governance actors, particularly COWSOs, gave groundwater users an opportunity to participate in decision making especially in formulating by-laws and allocating groundwater points. According to Chacha (2015), community participation creates a sense of ownership of water projects and hence sustainable water projects. These results contradict with previous studies that show poor community participation in water governance resulting possibly into poor governance and unsustainability of groundwater projects (Mandara *et al.*, 2013; Chacha, 2015; Kabogo *et al.*, 2017; URT, 2019a).

A synthesis through FGDs showed minimal collaboration between COWSOs and the village councils especially on the question of water charges and general conduct of groundwater governance. There was also poor collaboration between the district authority and village councils mainly because of the differences in the understanding of governance principles. Officials at the district level considered village councils and COWSOs not competent in groundwater governance. According to Mandara (2014); Matomero *et al.* (2017) and Kabote and Gudaga (2018), poor collaboration among different groundwater

governance actors particularly COWSOs and village councils: is explained by lack of transparency on financial matters.

According to Fierro *et al*. (2017), the National Water Policy (NAWAPO) of 2002 established COWSOs to enhance community participation in management of rural water supply, and the Water Supply and Sanitation Act No. 12 of 2009 recognizes COWSOs as the only legal water governance actor responsible for implementing NAWAPO's principle of participation. COWSOs membership comes from all hamlets and or each water point. Therefore, poor groundwater governance means that COWSOs do not practice governance principles as per the Good Governance Theory. According to the Water Supply and Sanitation Act No. 5 of 2019 (URT, 2019b), the name of the Community Owned Water Supply Organisations (COWSOs) has been changed to Community Based Water Supply Organisations (CBWSOs) to enhance community participation and other governance principles. The membership for CBWSOs includes a Community Water Committee (CWC) and Community Water Management Team (CWMT) as shown in Table 3.7. A synthesis through discussions with key informants in the villages reported poor transparency among governance actors including COWSOs particularly on financial reports prepared by COWSOs on income and expenditure of groundwater points. This is in line with Kifanyi *et al*. (2013), Kabote and Gudaga (2018), Nastar *et al*. (2018) and Obosi (2020) reporting about other countries in Africa including Tanzania implying that the problem is widespread.

Table 3.7: Set up and membership for CBWSO

Actor	Membership
Community Water Committee	• Supervisor who is the secretary, representative of educational institutions • Representative from health institutions, representative of VEO • Representative of WEO • Representative of women • Councillor and • Representative of groundwater users in the village
Community Water Management Team	Supervisor and Accountant

Source: URT (2019a)

Table 3.8 shows differences of respondents' responses about levels of groundwater governance whereas Table 3.9 and 3.10 present the difference in respondents' responses on groundwater governance by villages and difference in respondents' responses on groundwater governance by sex respectively.

Table 3.8: Difference levels of groundwater governance (n=250)

Level of groundwater governance	n	Mean Rank	Chi-Square	df	P-Value
Low	112	153.56			
Medium	53	112.06	15.939	2	0.000
High	85	126.73			
Total	**250**				

The results from the *Kruskal Wallis H test* shown in Table 3.8 show statistically significant difference between levels of groundwater governance (p = 0.000). The mean rank for low category was higher than the mean ranks for medium and high categories. This implies that the level of groundwater governance in the study area was significantly low at 5% level of significance. This can also be interpreted that governance actors including COWSOs and Village Councils do not practise governance principles effectively. These results contradict those by Gudaga *et al*. (2018) who showed effective groundwater governance in Mbarali District in the southern highlands of Tanzania. In that

study, COWSOs had a good relationship with other water governance actors. They were also accountable to stakeholders including groundwater users.

The *Kruskal Wallis H test* also showed statistically significant difference between localities in participation ($p = 0.000$), equitability ($p = 0.000$), efficiency ($p = 0.000$), rule of law ($p = 0.000$) and responsiveness ($p = 0.000$) (Table 3.9). Welela showed higher groundwater governance than other localities. Quantitative results were in line with qualitative results in that groundwater users participated in groundwater management regardless of their socio-economic and demographic differences in Welela. In addition, Rural Water Supply and Sanitation Agency (RUWASA) provided technical support to COWSO in Welela compared to other villages. Furthermore, FGD participants reported that groundwater users complied more with water rules in Welela. These explain higher or good groundwater governance in Welela relative to other villages.

Table 3.9: Difference in respondents' responses on groundwater governance by villages (n=250)

Governance principles	Villages	n	Mean Rank	Chi-Square	df	P-Value
Participation	Welela	78	158.95	32.551	3	0.000
	Kichiwa	46	97.41			
	Tagamenda	68	110.49			
	Kidegembye	58	125.35			
Accountability	Welela	78	132.46	4.139	3	0.247
	Kichiwa	46	110.95			
	Tagamenda	68	129.76			
	Kidegembye	58	122.68			
Transparency	Welela	78	130.23	5.339	3	0.149
	Kichiwa	46	107.05			
	Tagamenda	68	127.38			
	Kidegembye	58	131.56			
Equitability	Welela	78	176.06	69.781	3	0.000
	Kichiwa	46	91.12			
	Tagamenda	68	114.00			
	Kidegembye	58	98.26			
Efficiency	Welela	78	183.85	94.912	3	0.000
	Kichiwa	46	80.55			
	Tagamenda	68	100.49			
	Kidegembye	58	112.00			
Rule of law	Welela	78	186.71	93.415	3	0.000
	Kichiwa	46	90.02			
	Tagamenda	68	95.97			
	Kidegembye	58	105.95			
Responsiveness	Welela	78	155.52	26.336	3	0.000
	Kichiwa	46	100.95			
	Tagamenda	68	111.27			
	Kidegembye	58	121.28			
Collaboration	Welela	78	130.23	5.329	3	0.139
	Kichiwa	46	107.05			
	Tagamenda	68	127.38			
	Kidegembye	58	131.56			

The *Mann Whitney U test* showed statistically significant difference on the level of participation (p = 0.002), efficiency (p = 0.045) and the rule of law (p = 0.015) between male and female respondents (Table 3.10). The mean ranks for female respondents were higher than those of male respondents implying that females reported higher levels of

groundwater governance than males. This is attributed to gender roles in the African countries like Tanzania, were women are responsible for collecting water from different sources including groundwater sources for various use (Mandara, 2014; Graham *et al*., 2016; Nganyanyuka, 2017; Ngasala, 2018).

Table 3.10: Difference in respondents' responses on groundwater governance by sex (n=250)

Governance principles	Sex	n	Mean Rank	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Participation	Male	125	111.21	6151.500	14026.500	-3.082	.002
	Female	125	138.79				
Accountability	Male	125	127.54	7557.000	15432.000	-.533	.594
	Female	125	123.46				
Transparency	Male	125	128.28	7465.000	15340.000	-.722	.470
	Female	125	122.72				
Equitability	Male	125	130.73	7159.000	15034.000	-1.249	.212
	Female	125	120.27				
Efficiency	Male	125	117.16	6770.000	14645.000	-2.002	.045
	Female	125	133.84				
Rule of law	Male	125	115.04	6504.500	14379.500	-2.434	.015
	Female	125	135.96				
Responsiveness	Male	125	122.86	7482.000	15357.000	-.639	.523
	Female	125	128.14				
Collaboration	Male	125	127.53	7556.000	15431.000	-.532	.593
	Female	125	123.46				

3.5 Conclusions and Recommendations

The objective of this paper was to quantify levels of groundwater governance in Njombe District by using governance principles. The study found that the level of groundwater

governance in the study area was significantly low and differed by governance principles. Groundwater governance actors practised four of the governance principles poorly. The principles are accountability, transparency, collaboration and responsiveness. The rule of law was moderately well practised whereas participation, equitability and efficiency were well practised. This suggests measuring each of the governance principles separately when attempting to measure the overall level of governance.

Compliance with governance principles and nature of the existing relationships among groundwater actors at the village level differed by locality and hence differential levels of groundwater governance across localities. In this regard, higher groundwater governance levels were recorded in villages where groundwater governance actors complied well with governance principles, and hence supporting the Theory of Good Governance. It is therefore concluded that groundwater governance levels in Njombe District differ by localities.

Based on the conclusions, it is recommended that groundwater governance actors, particularly COWSOs, should practise effectively all governance principles with emphasis on those which are currently poorly practised that is, accountability, transparency, responsiveness, rule of law and collaboration. COWSOs should also ensure good relationship with Village Councils, RUWASA and other groundwater governance actors to ensure higher levels of groundwater governance.

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CHAPTER FOUR

4.0 Interactions among Groundwater Governance Actors in Njombe District, Tanzania

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4.1 Abstract

Information about groundwater governance actors' interactions is not clearly known in Tanzania. The general objective of this paper was examining the interactions among groundwater actors in the study area. The specific objectives were to identify groundwater governance actors in the study area and to examine their interactions in enhancing groundwater management in the study area. The paper deployed qualitative data collected mainly from key informants and secondary data. A total of 12 key informants were involved in interviews, guided by a checklist of items and squire matrix. Qualitative data were subjected to the content analysis while Social Network Analysis (SNA); through establishing the degree centrality, closeness centrality and betweenness centrality; were used to establish the interactions among governance structures. The study identified presence of various groundwater governance structures that were established to govern groundwater in the study area. The majority of groundwater governance structures contacted adequately with other groundwater governance structures. They obtained and/ or disseminated information efficiently related with groundwater governance or management in the study area. However, most of groundwater governance structures did

not link well with others or control cordially the flow of information from one structure to another. The paper concludes that groundwater governance structures were established and worked as per NAWAPO requirements. They interacted well among themselves particularly in sharing information related to groundwater governance and management in the district. However, the groundwater governance encountered insufficient control over information flow among governance structures. The study recommends that groundwater governance structures at the local level should maintain the existing groundwater governance structures to further enhance groundwater governance and management in the district. Groundwater governance structures at the local level should maintain the current interactions among themselves particularly of sharing information or other resources related with groundwater governance and management. Water stakeholders should provide capacity building related with interactions particularly on efficient control of information flow and linking other governance structures for groundwater governance and management matters.

Key words: Interactions, Groundwater governance actors, Njombe, Tanzania.

4.2 Introduction

Groundwater is an important natural resource that plays a great role in supporting livelihoods of the people. Margat and Gun (2013) show that about half of the world's population use groundwater every day. Groundwater contributes more than half of the universal production of the irrigated crops (Watson, 2007; Margat and Gun, 2013). However, there are challenges that affect groundwater including population growth, climate change and human activities causing groundwater depletion and pollution (MacDonald *et al*., 2012; Margat and Gun, 2013; Lapworth, 2017; Resende *et al*., 2017;

Xu *et al*., 2019). These affect availability and sustainability of groundwater. It is expected that by 2050, more than half of the global population growth will happen in Africa causing an increased water demand in the region to sustain this population growth (AMCOW, 2018). Therefore, such challenges call for effective groundwater governance and management to sustain the resource to support the increasing global population. Effective groundwater management will also help to achieve the Sustainable Development Goal No.6 which aims to ensure availability and sustainable management of water and sanitation for all (Bouma, 2016).

Interaction among groundwater governance actors has a bearing on effective groundwater governance for groundwater management. Scholars, including Opperman *et al*. (2009) and Harrington (2017), argue that lack of interactions among water governance structures is one of the prominent problems in the world. Ansell and Gash (2008) define interactions as a direct engagement of one or more public agencies institutions in decision making that aims to make, manage or implement public policy. Gray (1985) cited by Watson (2007), define interaction as a tendency of sharing resources such as information, money, and labour among others by two or more actors, to solve a set of problems that cannot be solved by an individual actor. In this study, the concept of interaction is defined as a tendency of groundwater governance actors to share information, money, expertise and labour among others to enhance effective groundwater management. This study uses the term actors to refer to people who are responsible for groundwater governance to enhance groundwater management while sturactures are the institutions of groundwater governance such as COWSOs, Village councils, RUWASA just to mention.

The Integrated Water Resources Management (IWRM), which Tanzania has adopted for coordinating development and management of water, land and related resources in order

to enhance livelihoods without compromising sustainability of the ecosystem (URT, 2002). That means the success of IWRM approach calls for effective interactions of water governance actors (Dungumaro and Madulu, 2002). Scholars like Knoepfel *et al*. (2007) and Adam and Kreisi (2007) argue that the interaction of actors is fundamental when dealing with water governance because it allows sharing mutual interests, institutions and resources among the actors. Furthermore, interaction among actors helps to share understanding and experiences of issues related to groundwater governance and management (Beierle and Konisky, 2001). The National Water Policy (NAWAPO) of Tanzania, through its Water Resource Management Act No.11 of 2009 and Water Supply and Sanitation Act No.5 of 2019 (URT, 2009; 2019), highlights specific roles of water governance actors as shown in Table 4.1.

On one hand, village councils are responsible for establishment and coordination of COWSO's budget, and COWSOs have to submit financial reports to the village councils. On the other hand, RUWASA should monitor COWSO's performance and undertaking including rehabilitation of water wells. Furthermore, the district council has a role of allocating funds for water supply and sanitation projects and approving by-laws for protection of water sources, operations of community organizations and other service providers among others (URT, 2009; 2019b).

Table 4.1: Roles of groundwater governance actors in Tanzania

Actors/Structures	Roles
Village council	• Promote establishment of COWSOs • Coordinate community organisation budgets with village council budgets • Resolve conflicts within COWSOs
COWSOs	• Own movable and immovable properties including public taps and waterworks; • Manage, operate and maintain public taps and waterworks and provide an adequate and safe supply of water to its consumers • Determine rules for the use of public taps and or waterworks by consumers • Install water meters for the purpose of measuring the amount of water supplied to a public tap or a consumer • Charge consumers for the water supplied from public taps and or waterworks; • Limit the access of any persons from the water source, who are not complying with the rules
District council	• Coordinate physical planning with the water authorities and community organizations • Set aside funds from own sources for water supply and sanitation projects • Approve by-laws for protection of water sources, operations of community organizations and other service providers
Water River Basin Authority	• Provide drilling groundwater permit • Enforce regulations related to groundwater management • Undertake groundwater quality testing
RUWASA	• Monitor COWSOs performance • Survey groundwater sources • Undertake drilling operations including water wells flushing and pumping test • Undertake rehabilitation of water wells • Enforce regulations related to groundwater management
Ministry of Water and Irrigation	• Coordinating and monitoring water authority strategies and plans • Monitoring performance of and regulate COWSOs • Ensuring the provision of technical guidance to local government authority and water authorities • Coordinating and providing technical and financial support for construction of water supply and sanitation schemes, and expansion or rehabilitation of existing schemes of national importance • Securing capital finance for schemes of national importance
Urban water Supply Authority	• Facilitating acquisition of necessary financing for rehabilitation and expansion water projects • Developing sewerage systems and general environmental sanitation • Establish financing mechanism to deal with emergencies of water services

Source: Adapted from URT (2002); (2009) and (2019b)

In addition, the River Water Basin Authority is responsible for providing water permit to drill groundwater and supervise general groundwater management. This shows that groundwater governance actors are interdependent in which they are supposed to be interactive for effective groundwater management.

Tanzania has no specific actors responsible for groundwater governance. The actors responsible for surface water governance are also responsible for groundwater governance. Thus, this study uses water governance and water governance actors to also mean groundwater governance and groundwater governance actors respectively. Although the roles of water governance actors are clearly stipulated in NAWAPO of 2002, the way actors practically interact for sustainable water governance is missing in the literature. The general objective of this paper was examining the interactions among groundwater actors in the study area. The specific objectives were to identify groundwater governance actors in the study area and to examine their interactions in enhancing groundwater management in the study area. The overarching question guiding this study was ‘how do groundwater governance actors interact to enhance groundwater management in the study area’?

4.3 Theoretical Framework

This study is guided by a Policy Network Theory (PNT) to assess the interactions among groundwater governance actors in the study area. The theory was developed from different studies including organizational, economics, sociology, anthropology, public policy and political science in the 1970s (Berry *et al*., 2004; Hudson and Lowe, 2009). Literature, including Rhodes (1997) and Compston (2009), define the concept of policy network as number of actors inside and outside governments who are involved in, or take

an interest of influencing public policy implementation or relations between mutually dependent actors. In addition, the theory asserts games and games arenas as an important concepts in policy processes. The concept of games refers to series of interactions among actors with the aim of influencing the implementation of public policies while game arena(s) refers to the places whereby games are played to influence public policy implementation (Scharpf, 1997; Koppenjan and Klijn, 2004). The theory emphases the importance of interaction among various actors inside or outside the structure by sharing resources, information and experience among others to solve public policy problems (Zheng *et al.*, 2010). Scholars have used the Policy Network Theory in different purposes and contexts. For instance, Leach *et al*. (1999) used this theory to investigate mutual interactions of various policy actors with the environment they manage in South Africa and Ghana whereas Jaffer (2013) adopted PNT to investigating the environmental policy process in Nairobi. These studies cemented that, actors interaction of policy planners and/ or implementers is vital aspect for effective policy implementation.

The PNT was relevant to guide this paper since the objective of this paper was to assess the interactions among groundwater governance actors in enhancing groundwater management. Thus the theory guided the study to assess the interaction of the respective groundwater governance actors, namely COWSOs, Villages councils, RUWASA, Rufiji water basin authority, district council, and private sectors at the local level. It is implied from the theory that, mutual interaction of groundwater governance actors is potential phenomena towards effective groundwater management in a country. The theory was applicable since it pays attention to ways in which actors communicate relative to, learn about, and influence natural resource management among themselves (Primmer, 2011).

4.4 Conceptual Framework

Figure 4.1 presents interactions among groundwater governance actors in supporting groundwater water management at a local level. The study argues that effective interaction of groundwater governance actors or structures are imperative to influence effective groundwater management such as protecting groundwater sources, paying water charges, reporting to groundwater officials in case of non-compliance among others in a particular locality (URT, 2009). Such effective interaction can involve various aspects such as sharing knowledge, experience, and resources that are necessary for groundwater management. For instance, RUWASA among other functions is responsible to provide technical support like drilling operations like water wells flushing and pumping test as well as undertaking rehabilitation of groundwater wells. Thus, it requires effective interaction with COWSOs because groundwater wells are owned by COWSOs.

Furthermore, the Water Resource Management Act No.12 of 2009 indicates that district councils, among others, are responsible to set aside funds from own sources for water supply and sanitation projects. Thus, there should be good interactions between district councils with other governance structures like village councils, COWSOs and RUWASA in identification and planning of groundwater development projects in the district. However, it is clear that the degree of interaction among governance structures or actors can vary from one governance structure to another.

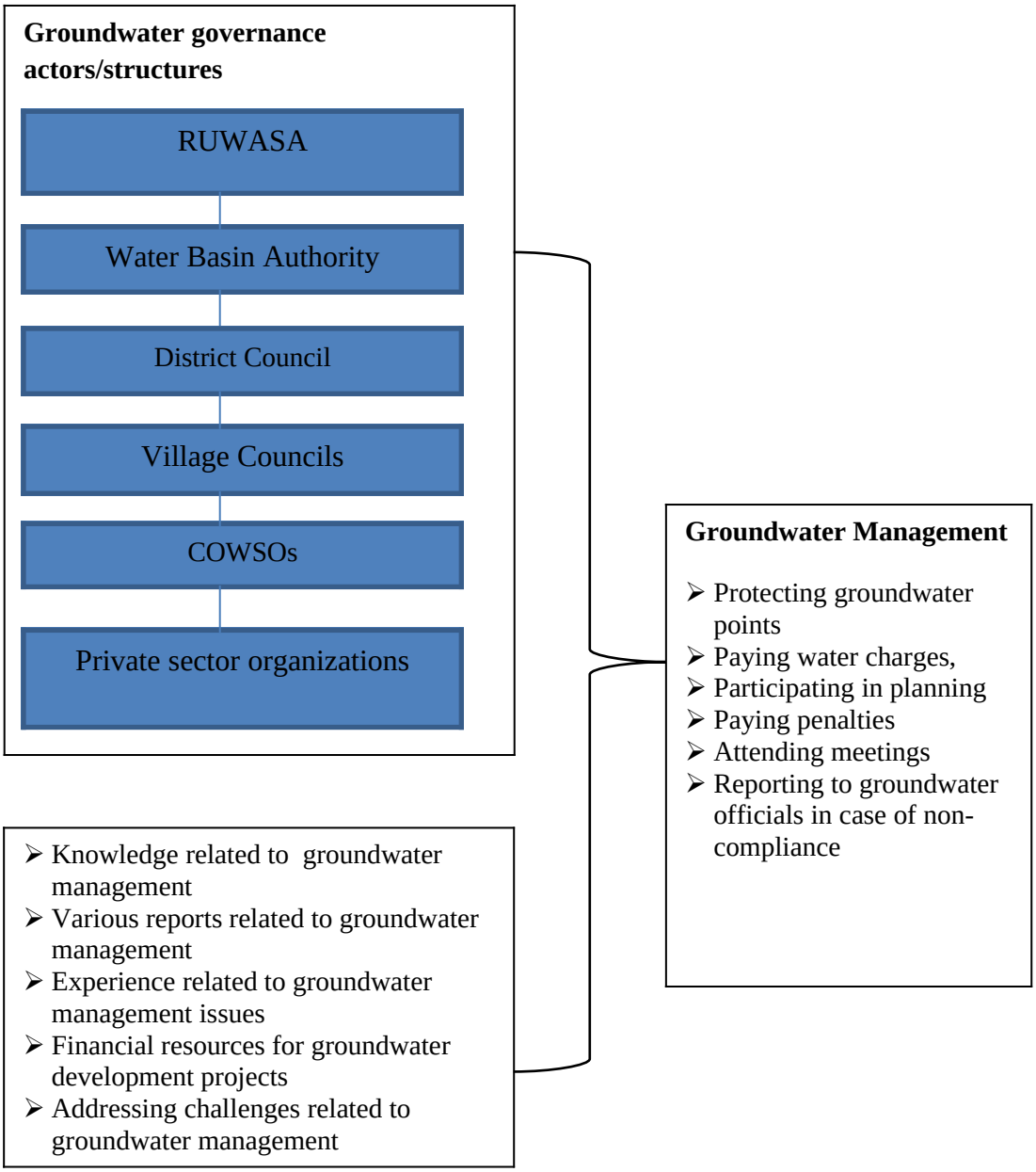

Figure 4.1: Interactions among groundwater governance actors at a local level

4.5 Methodology

4.5.1 The study area

The study was conducted in Njombe District, Njombe Region, Tanzania. Data collection took place between September and November 2019. By 2012 Njombe district had a population of 309 797 with the annual population growth rate of 1.6% (Tanzania National Bureau of Statistics, 2012), it is projected that by 2020 the district would have 349 453 people. The average annual rainfall is 1 500mm (Madzengo, 2014) with a single rainy

season that extends from November to April. The monthly temperature varies between 8°C to 24.7°C (Mtongori *et al*., 2015). Furthermore, the district population mainly depends on groundwater as source of water for domestic purposes. By 2016, the District had 65 water supply projects and 35 were groundwater projects (URT, 2009). This implies that groundwater constitutes 53.8% of all water projects in the district. However, about one-third of groundwater points are none-functional because they were not well maintained by groundwater users and were not rehabilitated by the responsible technicians (Communication with the Njombe Regional Water Director on 26/11/2018). This calls for an investigation with the aim to examine interactions and the reasons that hindered the relevant actors to address groundwater management issues.

4.5.2 Research design, sampling procedures and sample size

This manuscript deployed qualitative data collected mainly from key informants and secondary data. Key informants were required to provide information on interaction of a particular governance structure with other groundwater governance structures at a local level. A review of literature such as the NAWAPO 2002 and its Acts was applied to identify the roles of each water governance structure at the local level. Literature asserts that secondary data provides more information and are easily accessible than primary data (Vartanian, 2011). Qualitative data that were collected from in-depth interviews were analysed through content analysis whereby themes and arguments of different interviewees were summarized, compared and discussed.

Purposive sampling procedures were used to select two divisions namely Makambako and Lupembe. Purposive sampling is a technique in which particular settings respondents are selected deliberately in order to provide important information that cannot be obtained

from other choices (Maxwell, 1996). Four wards of Mtwango, Kichiwa, Igongolo and Kidegembye were also purposively selected based on availability of groundwater points. Under this study, groundwater points are the public sources of water in a particular village. Kothari (2006) recommends use of purposive sampling technique when the research focuses directly on an intended area of study. The information about availability of groundwater points was obtained from RUWASA officials. One village from each ward, making four villages, was selected using simple random sampling. This technique is easy and accurate to make generalizations about the larger population in relation with interaction of groundwater governance actors (Maxwell, 1996). The study involved key informants from COWSOs, village councils, RUWASA, district water department, Southern Highlands Participatory Organization (SHIPO) and UVINJO (Uchimbaji Visima Njombe) Group and Rufiji river basin office. SHIPO and UVINJO are private structures that deal with groundwater in the district and in the study area as well. Thus, a total of 13 key informants were involved for interviews.

4.5.3 Data collection methods and tools

The data collected through key informants were about nature of interactions with regard to degree, closeness and betweeness centralities. The social network analysts including Bolland (1988) argue that degree centrality is useful to identify the most popular actor in the network because it shows the number of actors or structures that are interacted with a particular actor or structure in the network. Rochat (2009) cements that the higher the degree centrality the higher the importance of a particular node in a network. In the context of this study, the degree centrality was used to identify the governance structures that demonstrated a most important role of enhancing groundwater governance and management by conducting with many other governance structures in the study area.

Closeness centrality is a useful measurement that detects how a particular node is near to other nodes in the network. In this case, the node in the nearest position average can most efficiently obtain or spread information to other nodes in the network (Bolland, 1988). In relation to groundwater governance, the study puts that the governance actor with high closeness centrality play a significant role of receiving and disseminating resources including information to other actors for effective groundwater governance and management in the study area.

In addition, betweenness centrality is useful measurement that detects the position of a particular node to link others as well as controlling the flow over information in a network (Wasserman and Faust, 1994). In addition, Amrit and Maat (2018) emphasizes on the importance of identifying the central actors in information flow networks because it helps to understand how people communicate or coordinate in the network. Thus, this paper used betweenness centrality to identify the position of each groundwater governance actor in linking others on groundwater governance or management as well as the ability to control the information flow related with groundwater governance or management. Principally, an actor with higher betweenness centrality would have more control over groundwater governance, because more information will pass through that governance actor. The key informant interviews were guided by a square matrix (Appendix 1).

The responses were coded in a square matrix whereas the key informants were required to identify the actors that interacted with other governance actor for groundwater governance. Furthermore, the interviewees were required to describe the types of information or resources that were shared among them. The matrix had two sections. The first section required data or type of information or resources that were normally received

by a particular structure or actor. The second section required data about information or resources that were normally sent to other groundwater governance actors at a local level.

4.5.4 Data analysis

Qualitative data were analysed using content analysis in which themes and arguments of different interviewees were summarized, compared and discussed. The Social Network Analysis (SNA) was used to establish interactions among groundwater governance actors. This tool is used for modelling, visualizing, and analysing interactions between individuals, within groups or organizations (Bolland, 1988), which was developed in 1930s (Wasserman and Faust, 1994) as a tool to analyse interactions or relationships between or among social actors (Scott, 1988). The tool focuses on the structure of ties within a set of social actors such as persons, groups, organizations, and nations (Degenne and Forsé, 1999; Scott, 2000). The tool has been used in various fields such as studying the spread of communicable diseases (Klovdahl, 1985) and managing natural resources (Pretty and Ward, 2001).

In this study, SNA was useful for mapping, describing and analysing interactions among groundwater governance actors. The data set were analysed using the software Gephi 0.9.2 (2008-2017). The software helped to generate image of interactions among groundwater governance actors that is visually interpreted. This was used to measure three centralities namely the degree centrality, betweenness centrality and closeness centrality among groundwater governance actors. According to Wasserman and Faust (1994), centrality is considered as one of the most main and commonly used conceptual tool for exploring actor’s roles in social networks.

However, literature does not show the cut- off point for significant interaction among actors in the Social Network Analysis. Thus, this study used a mean score as a cut-off point to identify the centralities levels of each groundwater governance actor. The mean score of each centrality was calculated by adding up the scores of all governance structures for a particular centrality then it was divided by the total number of governance structures as shown in the following formula.

$$A = \frac{\Sigma x}{N} \quad \text{..... (1)}$$

Whereas:

A = Mean

Σx = Sum of all the scores in the distribution

N = Total number of groundwater governance structures

The means scores of degree centrality, closeness centrality and betweenness centrality were 6, 0.5 and 6.37 respectively. Sykes *et al*. (2016) showed that the mean is useful to provide an overall idea or picture of a data set value. In this study, groundwater governance actors are considered as social networks that carry the interest of enhancing effective groundwater management. The following equation was used to calculate degree centrality C_D as defined by Rochat (2009).

$$C_D(X_i) = \frac{\deg(x_i)}{n-1} \quad \text{.....(3)}$$

n= Number of actors/Structures

$\deg(x_i)$= the degree of actor x_i

According to Bolland (1988) and Zhang and Luo (2017), the betweenness of a node *N* is calculated by considering couples of nodes and counting the number of shortest paths linking those two nodes, which pass through node *N*. Then the value is related to the total number of shortest paths linking each node of the two. Thus, the degree of betweenness centrality connotes the position of a particular node in linking other nodes in the network. In the context of this study, the betweenness centrality shows the position of a particular groundwater governance structure to link other groundwater governance structures in relation with groundwater governance and/or management activities. The social network analysts use the word node to mean actor and edge to refer links or contact (Bolland, 1988). The equation used to calculate betweeness centrality (^{B_C}) of a vertex (v), is as follows:

$$B_C(V) = \sum_{u,v,\in v} \left(\frac{\sigma uw(v)}{\sigma uw}\right) \quad \text{.....(4)}$$

Where:

σuw = total number of node's (actor's) paths (links) between node (structure) *u* and *w*

$\sigma uw(v)$= total number of nodes' paths (links) between node (structure) *u* and *w* that pass through *v* (a particular governance actor).

Moreover, closeness centrality was used to detect nodes that are able to spread or control the flow of information very efficiently in the network. According to Rochat (2009), closeness centrality indicates how a particular node is close to all other nodes in terms of sharing or controlling the flow of information in the network. Ideally, the nodes with a high closeness score have the shortest distances that suggest efficient position to spread or

control the flow of information to all other nodes in the network. In addition, the equation used to calculate closeness centrality (C_C) as defined by Bavelas (1950) is shown as:

$$C_C(x) = \frac{1}{\sum_y d(y,x)} \quad \text{.....(5)}$$

Where,

$d(y, x)$ is the distance between the vertices (nodes) x and y

4.6 Results and Discussion

4.6.1 Key informants' demographic characteristics

The characteristics of key informants of groundwater governance actors are shown in Table 4.2. The results showed that the key informant interview deployed both males and females of different levels of education. However, the total number of males was higher than females' key informants. This suggests that men were the majority who held leading positions of groundwater governance than women in the study area. However, literature shows outstanding women participation in local water governance structures in some parts of Tanzania (Kabote and John, 2017; Mandara *et al.*, 2017). In addition, the results show that about half of the interviewees had standard seven education level. This implies that the majority had acquired basic education that can help them to write and possibly to do simple reasoning related to water governance. Knowing the importance of education level of groundwater governance actors particularly in COWSO leadership, recently known as Community Based Water Supply Organisations (CBWSOs) leadership, the Government of Tanzania through its Ministry of Water has established the qualifications of supervisors and accountants of CBWSOs. The Water Supply and Sanitation Act No.5 of 2019 stipulates that the supervisors and accountants of CBWSOs should at least be qualified water technicians with a certificate of grade III and assistant accountant with certificate of

accountancy grade III (URT, 2019b). Certainly, the reform aims to improve groundwater governance and management in the country.

Table 4.2: Key informants characteristics

Groundwater governance structure	Designation	Sex	Education level
COWSO Welela	Secretary	Male	Standard Seven
COWSO Kichiwa	Secretary	Male	Standard Seven
COWSO Tagamenda	Secretary	Female	Standard Seven
COWSO Kidegembye	Secretary	Male	Standard Seven
Tagamenda village council	Village Chairperson	Male	Standard Seven
Welela village council	Village Chairperson	Male	Standard Seven
Kichiwa village council	VEO	Male	Form four
Kidegembye village council	Village Chairperson	Male	Standard Seven
Rufiji River Basin	Acting Director	Male	PhD
District council	Planning officer	Male	First Degree
RUWASA	District director	Male	First Degree
SHIPO	Asst. Manager	Female	First Degree
UVINJO Group	Manager	Male	Diploma

4.6.2 Groundwater governance actors

Through interview with RUWASA officials the study identified thirteen groundwater governance structures that are responsible for groundwater governance in the study area. Those governance structures include COWSOs, Village Councils, District Council, SHIPO and UVINJO group. SHIPO and UVINJO group are non-governmental organizations that were involved in groundwater related functions such as drilling wells and providing technical support for groundwater management. The key informants revealed that groundwater governance actors played important but different roles in enhancing groundwater management. For instance, the RUWASA, as reported by RUWASA official, supervised COWSOs in order to facilitate performance and provide technical support to COWSOs like flushing wells, pumping test and wells' rehabilitation. This was in line with what is stipulated in the National Water Policy of Tanzania (URT, 2002).

The performance of groundwater governance actors particularly RUWASA was affected by delay of funds from the central government. This is justified in the following quotation:

> "*The execution of RUWASA activities mainly depends on the funds from the central government. But sometimes the central government delays to remit the funds hence it constrains the effectiveness of this office. For instance, the budget of 2018-2019 was released almost one month before the end of the financial year. Thus, we were unable to conduct field supervision and fulfilling other important activities*" (RUWASA Official).

The challenge of limited financial resources was also reported by key informants in Rufiji River Basin Office. It was reported that sometimes the Rufiji River Basin officials failed to go in the field to monitor groundwater points and enforce regulations related on groundwater management because of limited resources. This implies that groundwater governance at the study area was constrained by limited resource particularly financial resources. The results do not deviate from previous studies including of Katomero *et al.* (2017) and Komakech and de-Bont (2018) whereby it was found that water governance is jeopardized by unreliable funds flows from central governments to support water governance at the local level.

The key informants showed that there were 60 COWSOs in 69 villages registered by the district council. However, some villagers were reluctant to establish COWSOs because of limited awareness of the importance of COWSOs, as reported in the following quotation from RUWASA officer:

> "*In some villages people are not willing to establish COWSOs because of fearing that they will be forced to adopt water charge system. Thus, we are trying to enlighten them on the advantages of COWSOs like ownership of groundwater projects.*"

This suggests that apart from the success of the district to register COWSOs some people were not well informed on the importance of COWSOs for groundwater management in some villages. Evidence from Dodoma region of Tanzania shows that the concept of COWSO is not well known by the majority of the community members (Fierro *et al*., 2019).

Through direct observation the study identified public and individual households' groundwater points in the study area. However, groundwater governance actors managed only public groundwater points as reported by SHIPO key informant in the following quotation. *"If you survey at the households you will find shallow wells, which are not recognised by the government in terms of numbers and the way they are operated"* (SHIPO key informant). This was also reported by the key informant from Kichiwa village council. Therefore, it is clear that the abstraction and protection of groundwater from the household owned points are not monitored by the responsible groundwater governance structures at the study area. Possibly, groundwater users from the households owned points obtained groundwater for domestic uses from unprotected sources, something that can prone households to drink contaminated water thereby affecting the public health. Ideally, leaving the household owned groundwater sources without being managed by the groundwater governance structures puts the groundwater governance and management questionable in the study area. A lesson from Arusha city shows that most of the households-owned groundwater points are shallow wells, which are more vulnerable to pollution (Komakech and Bont, 2018). The solution for this problem is to encourage groundwater governance actors to stretch a hand to also include households-owned water points in their management plans.

4.6.3 Centralities of water governance actors

Figure 4.2 and Table 4.3 present interactions with regard to degree centrality, betweenness centrality and closeness centrality among groundwater governance actors in the study area.

4.6.3.1 Degree centrality

Table 4.3 shows the degree centrality among groundwater governance structures in the study area. The results showed that seven out of thirteen groundwater governance structures namely Welela COWSO, Tagamenda COWSO, SHIPO, UVINJO group, district council, Rufiji River Basin authority, and RUWASA scored above the mean. This implies that the majority groundwater governance structures conducted adequately with several groundwater governance structures on groundwater governance and management matters in the study area. Although the majority groundwater governance structures corresponded adequately with several governance structures, yet the scores of degree centrality differed among groundwater governance structures. For instance, the results show that RUWASA had 12 links which is higher than any other structures' links while Rufiji River Basin and COWSOs from Tagamenda and Welela villages were slightly high. Principally, the variation of degree centrality can affect the overall effectiveness of groundwater governance and management in the study area.

Table 4.3: Degree centrality, closeness centrality and betweeness centrality

Governance structure	Indegeree	Outdegree	Degree centrality	Closeness centrality	Betweenness centrality
Kidegembye VC	2	2	4	0.39	0.11
COWSO Kidegembye	1	2	3	0.47	1.58
Kichiwa VC	1	2	3	0.47	1.58
COWSO Kichiwa	2	2	4	0.42	0.18
Welela VC	2	1	3	0.50	3.25
COWSO Welela	2	4	6	0.60	6.41
Tagamenda VC	2	2	4	0.52	0.83
COWSO Tagamenda	3	3	6	0.55	0.23
RUWASA	7	5	12	0.69	36.50
UVINJO group	4	3	7	0.55	0.28
SHIPO	4	5	8	0.69	11.41
District council	6	3	9	0.56	17.75
Rufiji River Basin Authority	4	2	6	0.50	2.75

The results from Table 4:3 correspond with the results from Figure 4.2 whereas RUWASA shows higher number of direct contacts with other governance structures including COWSOs, district council, Rufiji River Basin and Village Councils compared to other governance structures. The key informant in RUWASA reported that RUWASA linked with various water governance structures to enhance groundwater management in the district. For instance, RUWASA consulted COWSOs on rehabilitation of groundwater points. It also shared information with the district council and Rufiji River Basin Authority about groundwater management. Furthermore, RUWASA linked COWSOs to Rufiji river basin authority to obtain drilling groundwater permits and testing groundwater qualities. This implies that RUWASA interacted with many groundwater governance structures than others to enhance groundwater governance and management in the district.

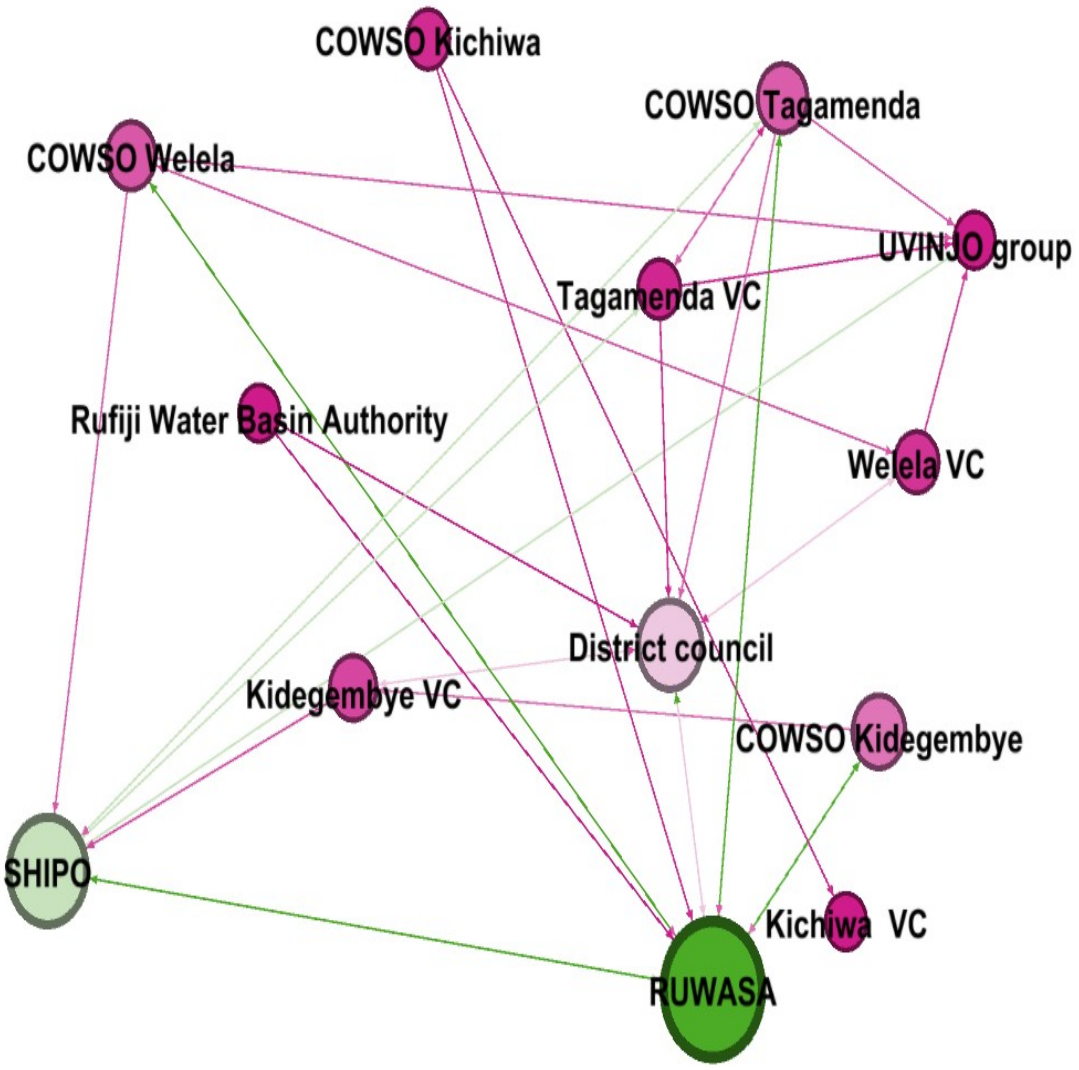

Figure 4.2: Interactions among water governance structures.

Literature reveals that RUWASA plays an important role in collaboration with other governance structures in supporting groundwater management in the country (URT, 2019a; United States Agency for International Development, 2020).

4.6.3.2 Closeness centrality

Looking at the column of closeness centrality (Table 4.3), the results showed that nine out of thirteen governance structures had equal to or above the mean scores (0.5) which suggests high closeness centrality. This implies that the majority of the groundwater governance structures were in a position of obtaining and disseminating information or

resources related with groundwater governance among them in the study area. The groundwater governance structures that scored above the mean include: Welela village council, Tagamenda village council, Welela COWSO, Tagamenda COWSO, SHIPO, UVINJO group, district council, Rufiji River Basin authority, and RUWASA.

Nevertheless, the extent of closeness centrality differed among groundwater governance structures. For instance, the results show that RUWASA and SHIPO had 0.69 which is higher than others groundwater governance structures. This implies that RUWASA and SHIPO were the most efficient governance structures to obtain and/or disseminate information related with groundwater governance and management to other governance structures in the study area. In addition, 6 governance structures namely Rufiji River Basin Authority, Welela village council, Tagamenda village council, COWSO from Tagamenda, UVINJO group and district council were slightly efficient in disseminating information or resources to other governance structures to enhance groundwater governance or management in the district.

Referring to Figure 4.2, RUWASA and SHIPO had direct contacts with more than half of all governance structures for various issues related with groundwater governance in the study area. This connotes that RUWASA and SHIPO were the popular governance structures to enhance groundwater management in the district. For instance, during interview with RUWASA key informant, it was reported that RUWASA received monthly reports from COWSOs as shown in the following quotation: "*we normally receive monthly reports from COWSOs showing progress of their activities … we also take initiatives of contacting COWSOs that do not submit progress reports timely"* (RUWASA key informant).

In addition, RUWASA visited communities in the villages to address issues related to groundwater management. Furthermore, key informant from SHIPO reported that SHIPO was in contact with other governance structures such as UVINJO group, COWSOs and village councils by sharing technical support for groundwater development and management. This implies that RUWASA and SHIPO had higher level of efficiency than other governance structures in influencing groundwater governance interests in the study area. Principally, RUWASA is newly established agency by the Ministry of Water with expectations of enhancing effective development and sustainable management of water supply and sanitation projects and water service delivery in rural areas (URT, 2019b).

Moreover, the position of SHIPO and UVINJO group in influencing groundwater governance in the study area signifies the importance of private sector for groundwater governance and management. Literature including Tanzania Water and Sanitation Network (2019) reported that private sector plays great role of enhancing effective water management in general by emphasizing water stewardship. The concept of water stewardship is defined by Tanzania Water and Sanitation Network (2019) as water use which is socially equitable, environmentally sustainable and economic beneficial.

4.6.3.3 Betweenness centrality

Betweeness centrality was used to identify the most powerful groundwater governance structures to link others on matters related with groundwater governance matters. In addition, betweeness centrality was used to identify efficient governance structures in controlling information flow from one governance structure to others. Looking at the column of betweenness centrality (Table 4.3), the results showed that only 4 governance structures namely RUWASA, SHIPO, district council and COWSO from Welela village

had high betweenness centrality. The rest governance structures scored below the mean score (6.37). This implies that the majority governance structures did not link well with others or control efficiently the information flow related with groundwater governance matters. Eventually, a minimum control over the flow of information or resources from one governance structure to another one can limit the opportunity of sharing knowledge, skills, resources and challenges for effective groundwater governance in the place.

The highest scores were 36.50 for RUWASA, followed by 17.75 scores for district council. This suggests that RUWASA had higher influence over the flow of information and resources among governance structures in the study area. During the discussion with RUWASA key informant, it was reported that RUWASA linked other governance structures in different aspects. For instance, RUWASA linked COWSOs to Rufiji Water Basin Authority in the process of getting permits for groundwater abstractions. In addition, RUWASA disseminated information from Rufiji Water Basin to COWSOs related with enforcement of various groundwater management regulations such as undertaking groundwater quality testing in groundwater points. Previous studies show that RUWASA is an imperative water governance structure to influence effective groundwater governance by providing valuable information for effective water management both at the local and national level (URT, 2019a; Musa, 2020).

4.7 Conclusions and Recommendations

The objective of this paper was to examine interactions among groundwater governance actors in the study area. It was found various governance actors that interacted to enhance groundwater management. Therefore, the study concludes that groundwater governance actors were established and worked as per NAWAPO requirements. In relation with the

centralities measurements, the study found that the majority of the groundwater governance actors had adequate number of contacts with others, and they were in a position of obtaining or sending efficiently the information related with groundwater governance and/or management to other governance actors. Therefore, it is concluded that groundwater governance actors in Njombe District interact well among themselves particularly in sharing information related with groundwater governance and management.

Furthermore, the study found that most of groundwater governance actors did not link well with others or control cordially the flow of information from one actor to another. In addition, the centralities measurements showed that the level of interaction among groundwater governance actors differed among themselves. Thus, the study concludes poor control of information flow from one governance actor to another and the different levels of interactions among groundwater governance actors constrained the intended groundwater governance hence ineffective groundwater management. This concurs with the policy network theory which asserts that effective interaction of all actors in a network is imperative to achieve the intended goals of a particular organization.

Based on the conclusions, this paper recommends that groundwater governance actors at the local level should maintain and develop the existing groundwater governance actors to further enhance groundwater governance and management. In addition, the study recommends that groundwater governance actors should maintain the current interactions among themselves particularly of sharing information or other resources related with groundwater governance and management. This will sustain and foster effective groundwater governance and management. Lastly, the study recommends that the District

authority and other stakeholders should provide capacity building related to interactions particularly on efficient control of information flow and linking other governance structures for groundwater governance and management matters. This will facilitate the accessibility and availability of information or resources that are imperative for effective groundwater governance at the local level.

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CHAPTER FIVE

5.0 Groundwater Users' Compliance with Groundwater Institutions in Tanzania: A Case of Njombe District

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5.1 Abstract

Groundwater users' compliance with groundwater institutions in Tanzania is not well explored. The general objective of this paper was to analyze factors that influence groundwater users' compliance with groundwater institutions. The specific objectives of this paper were to measure the levels of groundwater users' compliance with groundwater institutions and to analyze influence of groundwater governance and management factors on users' compliance with groundwater institutions. The study was guided by the New Institutional Theory to establish the level of compliance and Contextual Interaction Theory to deternine the influence of groundwater governance and management factors on compliance with groundwater institutions. The study adopted a cross-sectional research design with a random sample of 250 respondents while qualitative data were subjected to the content analysis. Ordinal logistic regression analysis was used to determine the influence of governance principles on compliance with groundwater institutions. Chi-squire test was used to determine whether the respondents' socio-demographic

characteristics and the approximate distance from the respondents' households to groundwater points influenced groundwater users' compliance with groundwater institutions. Overall, groundwater users' compliance was medium, and this was reported by 54.4% of the respondents. Based on the ordinal logistic regression analysis, compliance was mainly influenced by availability of groundwater (Wald = 7.694, p = 0.006), quality of groundwater (Wald = 20.408, p = 0.000) and participation (Wald = 13.397, p = 0.000). The results from Chi-squire test showed that the distance from the respondents' households to groundwater points (p = 0.006), sex (p = 0.000), education level (p = 0.000) and annual income of the respondents' households (p = 0.01) influenced significantly the groundwater users' compliance with groundwater institutions. It is concluded that groundwater characteristics, the practice of governance principles particularly participation in decision making, accessibility of groundwater, and socio-demographic characteristics are essential aspects to influence groundwater users' compliance with groundwater institutions. The study recommends that groundwater governance actors including the district water officials, village councils and COWSO leaders should practice well the good governance principles in the study area. Also the study recommends that local government authority and other water development stakeholders should increase number of groundwater points within the recommendable distance. Furthermore, the groundwater users' socio-demographic characteristics particularly sex, education level and households' income of the groundwater users should be considered by groundwater governance actors to enhance effective groundwater management at the local level. This will further increase the level of compliance with groundwater institutions.

Key words: Compliance, Institutions, Groundwater, Management, Njombe, Tanzania

5.2 Introduction

Groundwater users' compliance with groundwater institutions is imperative for groundwater governance and management. Globally, the question of compliance with groundwater institutions is one of the under researched areas (Holley *et al*., 2020). Compliance is a situation to obey rules and agreements, in this case, rules for groundwater governance while groundwater institutions refer to rules that govern water users' behaviour (Iza and Stein, 2009; FAO, 2016). Bandaragoda (2000) and Ostrom (2007) view water institutions as rules of the game that influence players' behaviour in the governance process. Others, including MacDonald *et al*. (2012) consider water institutions as guidelines that describe who do what, when and how water should be governed. These definitions imply that water institutions, whether formal or informal, are critical for effective water management. In the context of groundwater management, rules of the game are the groundwater institutions that are established by water authorities to influence groundwater users' behaviour (Katomero *et al*., 2017; Nganyanyuka, 2017). Varady *et al.* (2016) argue that groundwater institutions help to organize human efforts for proper tapping, distribution and management of groundwater.

In different periods, Tanzania has undergone a significant transformation of legal frameworks governing water management, including groundwater, in the country. Historically, during the pre-colonial era water resources including groundwater were managed by customary rules until the early 1900s when the German and British settlers introduced formal water laws (Sokile *et al*., 2003). Soon after independence in 1961 until 1980 water governance was absolutely vested by the national government. But from 1981 onwards, the government delegated water governance authorities to the basin boundaries to foster governance of water management in the country (van Kappen *et al*., 2004;

Kabudi, 2005). Toonen (2011) defines water management as a practical social response with a given means or conditions to sustain water resource in a particular area.

Literature shows that around the 1990s and 2000s water governance in Tanzania was subject to a comprehensive reform that came up with the 2002 National Water Policy and the 2009 Water Resources Management Act (Kabogo *et al*., 2017; Graffton *et al.,* 2019). The 2002 National Water Policy and the 2009 Water Resources Management Act structure the water governing authorities in five management levels. These levels are (i) national; (ii) basin; (iii) catchment; (iv) district; and (v) community (URT, 2002). At the national level, the Ministry of Water and Irrigation is the highest water authority with responsibilities of formulating and updating policies and Acts in the country. Under the Ministry of Water, there are nine Basin Water Boards responsible for allocating and enhancing protection of water resources. In line with the Basin Water Boards there are Catchment Water Committees. The Catchment Water Committees are responsible for coordinating Integrated Water Resource Management (IWRM) plans and to resolve regional water conflicts. The district council is responsible for conflict resolution, planning for water infrastructures and establishment of Community Owned Water Supply Organizations (COWSOs) (Muyinga, 2013; Manero, 2018). COWSOs are responsible for governing water management at the possible lowest level.

Tanzania, through the Ministry of Water and Irrigation established various water Acts including the Water Resource Management Act (WRMA) No. 12 of 2009 and the Water Supply and Sanitation Act No. 5 of 2019 to support groundwater governance in the country. The Acts require the water users, through Community Owned Water Supply Organizations (COWSOs), to take a leading role on groundwater governance by

complying with water rules (URT, 2009; 2019b). These include protecting groundwater sources from pollution, paying penalties in case of non-compliance with the existing groundwater rules, paying charges for water and participating in decision making of various activities related to groundwater management (URT, 2019b).

Although Tanzania has water institutions in place, groundwater is ineffectively managed. The country witnesses groundwater pollution and malfunctioning of groundwater infrastructures in various parts of the country (Sappa and Lucian, 2014; URT, 2016; World Bank, 2018; Lufingo, 2019). For instance, a research carried out in Kinondoni, Temeke, Hai, and Siha Districts by Nganyanyuka (2017) shows that 69% of shallow wells and 55% of the hand pumps were not functioning due to poor management. Generally, one third of the water points are not functioning in Tanzania (URT, 2020). Literature, including Sweyaa *et al*. (2018) shows that failure to comply with water rules leads to poor water governance.

Studies, for example by Mosha *et al.* (2016); Masifia and Sena (2017), show low compliance of surface water users with water institutions. However, groundwater users' compliance with groundwater institutions such as paying water charges, protecting groundwater sources, paying penalties when groundwater users faced with non-compliance among others in Njombe District is not well known. The general objective of this paper was to analyze factors that influenced groundwater users' compliance with groundwater institutions. The specific objectives of this paper were to measure the levels of groundwater users' compliance with groundwater institutions and to analyze factors that influenced groundwater users to comply with groundwater institutions.

5.3 Theoretical Framework

This paper is guided by two theories, namely the New Institutional Theory and the Contextual Interaction Theory, to assess the levels of groundwater users' compliance with groundwater institutions and factors that influence the compliance respectively.

5.3.1 New Institutional Theory

The evolution of the New Institutional Theory (NIT) goes back to the late 1970s and early 1980s. The theory was developed by John Meyer and his colleagues including Brian Rowan and Richard Scott (Powell, 2007). The main argument is that individuals' compliance with institutions leads to successful implementation of the plans (Lipnicka and Verhoeven, 2014). This implies that compliance with institutions is essential for achievement of objectives of any particular organization. The theory has been a useful guidance in various social sciences including management and political science studies in assessing compliance (Lang, 2019). In addition, Kraft and Furlong (2017) assert that NIT is a policy implementation mechanism that emphasizes on compliance with institutions.

Viewed in the context of this study, the theory was appropriate because the study involved the concept of compliance with groundwater institutions for groundwater management. Principally, groundwater institutions in Tanzania are well stipulated in the Water Resource Management Act No.12 of 2009 and the Water Supply and Sanitation Act No. 5 of 2019. For instance, the Acts require groundwater users to pay water charges and protect groundwater sources, among other things (URT, 2002; 2009; 2019b). The intention of establishing groundwater institutions in the country is to enhance effective groundwater management. Thus, groundwater users' compliance with those directives is imperative for effective groundwater management in the country. Limited groundwater users' compliance with groundwater institutions can cause ineffective groundwater management.

5.3.2 Contextual Interaction Theory

The Contextual Interaction Theory (CIT) was developed from the policy implementation studies that began in the early 1970s (Pressman and Wildavsky, 1973; Wildavsky, 1973). In the late 1990s the theory was developed as a theory of implementation in the Netherlands (Owens and Bressers, 2013). The theory has been used in different studies to assess implementation of various policies including the policy of water, energy and environmental management in various countries (Owens and Bressers, 2013; Hueso and Bell, 2013; Mohlakoana, 2014). The theory identifies three main characteristics of policy implementers or targets that can influence best policy implementation. These characteristics are the motives that drive their actions, cognition in terms of true information related to the implemented policy and resources that provide capacity to implement policy (Bressers, 2007). The implementer is an actor who officially commissioned with promoting the envisaged measures, and the target is the actor necessary to realize policy measures such as citizens (Owens and Bressers, 2013). Under this study, groundwater users are regarded as the target group through the decentralized water governance system in Tanzania (URT, 2002), while the water governance authorities or water governance actors are the implementers.

Basically, the groundwater users' compliance with groundwater institutions is fundamental for better NAWAPO implementation. The purpose of NAWAPO, through its water Acts, is to ensure effective and sustainable groundwater management. Also, groundwater users as the key resource beneficiaries are given a leading role of groundwater management at the lowest level (URT, 2002). This study asserts that the practice of governance principles, groundwater characteristics and the background characteristics of groundwater users are the drivers of individuals' compliance with

groundwater institutions. CIT was appropriate because the study intended to determine factors that drive groundwater users to comply with groundwater institutions.

5.4 Conceptual Framework

Figure 5.1 presents factors influencing groundwater users' compliance with groundwater institutions. It is hypothesised that groundwater users' compliance with groundwater institutions, as the dependent variable, can be influenced by the practice of groundwater governance principles (FAO, 2016) and groundwater characteristics. Therefore, if the governance principles (Table 5.1) are well practised by the groundwater governance actors, the groundwater users will be encouraged to comply. Furthermore, the characteristics of groundwater resources such as its quality, availability, and accessibility can also influence the behaviour of groundwater users to comply with groundwater institutions (Mechlem, 2016). Indeed, groundwater governance and the groundwater quality can influence groundwater users' preference, motivation and actions of groundwater management by complying with the groundwater institutions.

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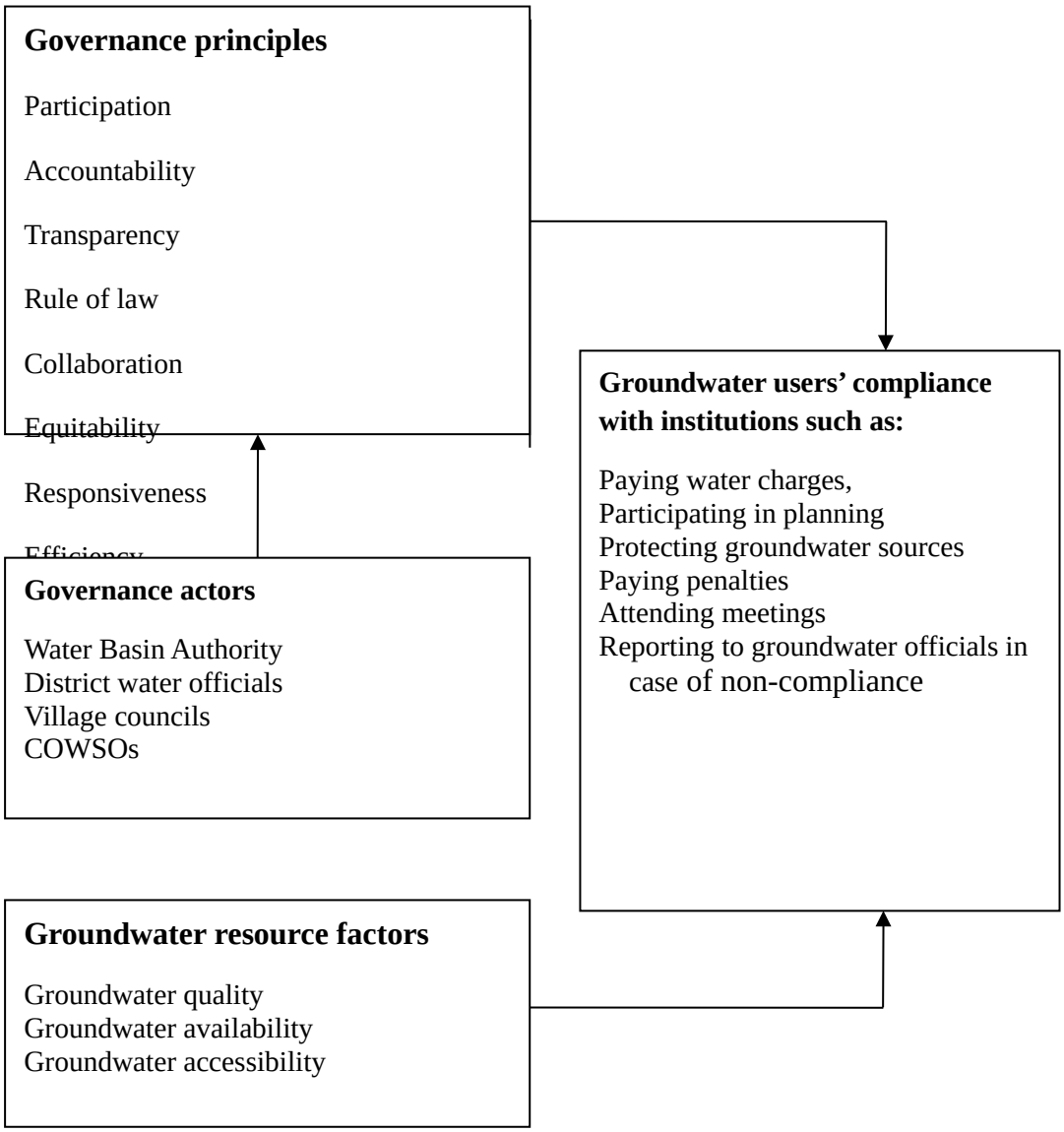

Figure 5.1: Groundwater users' compliance with groundwater institutions

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Table 5.1: Operational definitions of governance principles

Variable	Operational definition	Reference
Participation	Offering the community an opportunity for making decision, owning, planning and budgeting resources	UNDP (1997); Burns *et al*. (2004)
Accountability	A tendency of groundwater governance actors being responsible for their actions in relation to groundwater management matters	Lockwood *et al.* (2010); Zaag and Savenije (2014)
Efficiency	Availability, accessibility and protection of groundwater resource	Abrha (2016)
Transparency	Availability and accessibility of information related to groundwater governance	Sanz *et al*. (2016); Lockwood (2010)
Equitability	Providing equal opportunities to communities regardless of their socio-demographic differences	UNDP (1997); Lockwood (2010).
Collaboration	Working actively with different actors	Graham *et al. (*2003)
Responsiveness	Reacting actively and timely on groundwater management matters	Abrha (2016)
Rule of law	Applying clearly and uniformly water rules to all groundwater users	Zaag and Savenije (2014); Abrha (2016)

5.5 Methodology

5.5.1 The study area

The study was conducted in Njombe District, Njombe Region, Tanzania (Figure 5.2). Data collection took place between September and November 2019. Njombe District is divided into three district councils namely Njombe Rural District, Njombe Town Council and Makambako Town Council. According to the 2012 Population and Housing Census (NBS, 2012), Njombe District had a population of 309 797 people. The report also shows that the annual population growth rate in Njombe District was 1.6%.

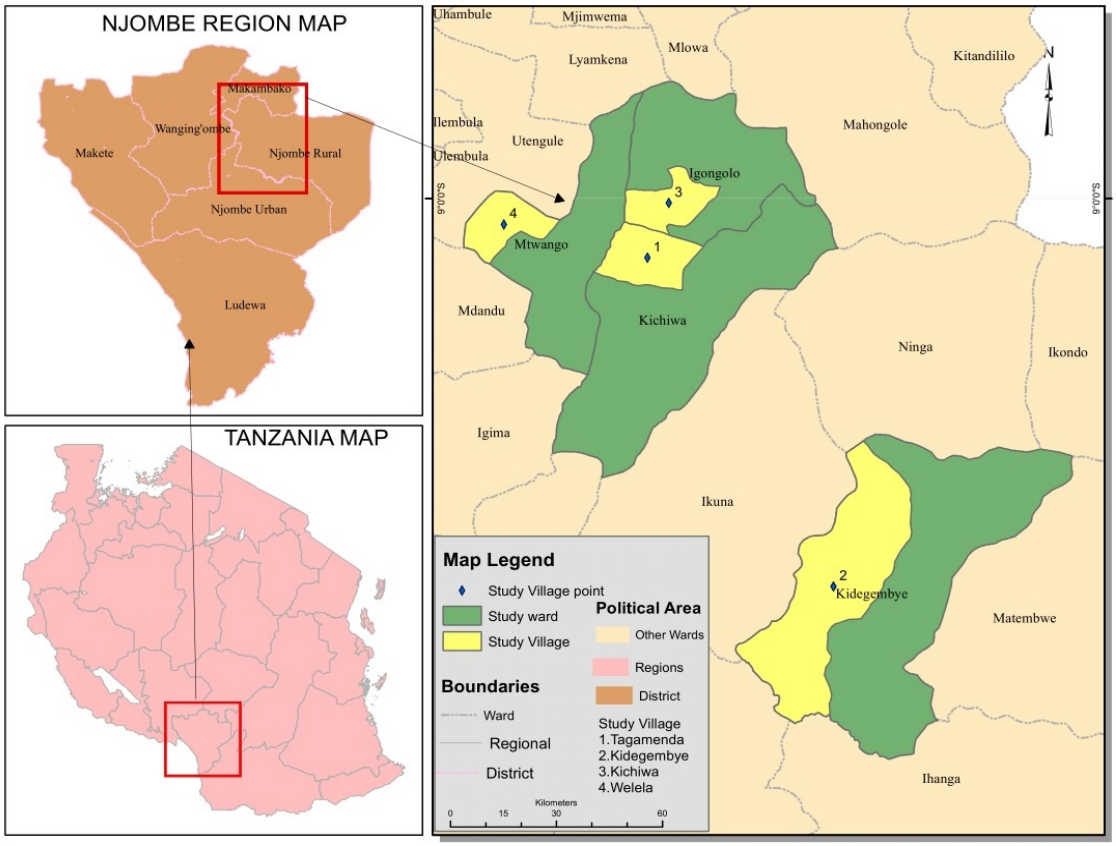

Figure 5.2: Location map of Njombe District showing the study area

Using population projection model recommended by Carmichael (2016) and George *et al.* (2004), the district population is projected using the follow equation:

$$P_p = P_t + (1 + r)n \quad \text{..... (1)}$$

Where P_p = population in the target year; P_t = population in the launch year; r = annual population growth rate, and n = difference between censused year, which is 2012 in this case. Thus, substituting the values into equation 1, the population of Njombe District is expected to be 349 453 by the mid-2020. Population information is important for proper planning of social services like groundwater supply and management.

The district has an average annual rainfall of 1 500mm (Madzengo, 2014), and it is characterised by unimodal climate, with a rainy season extending from November to April. The monthly temperature varies between 8 °C and 24.7°C (Mtongori *et al*., 2015). The district has various sources of water including river Ruhuji and springs (NBS, 2012). According to Water Sector Status Report 2015-2020, it is reported that 80% of the population in Njombe District has access to clean and safe water (URT, 2019a). By 2016, the district had 65 water projects for water supply services whereas 35 of the projects were groundwater sources (URT, 2016a). This implies that groundwater constitutes 53.8% of all water sources in the district. However, the district encounters various challenges related to compliance with groundwater institutions including protecting groundwater infrastructures and illegal abstraction of groundwater sources (Holtslag and Mgina, 2016; URT, 2016a; 2016b).

5.5.2 Research design, sampling procedures and sample size

This study adopted cross-sectional research design that mixed quantitative and qualitative approaches in order to triangulate and complement data sources (Creswell, 2014). Cross-sectional research design is useful when a study collects data from one point in time without repetition from the sample population (Bailey, 1998; Kesmodel, 2018).

Two divisions, namely Makambako and Lupembe, were selected using purposive sampling procedure. Four wards of Mtwango, Kichiwa, Igongolo and Kidegembye were purposively selected in the divisions. The divisions and wards were selected based on availability of groundwater points (Table 5.2). Kothari (2006) recommends use of purposive sampling technique when as research focuses directly on the intended area of study. The study used officials from Rural Water Supply and Sanitation Agency

(RUWASA) to obtain information about the presence of groundwater points in the wards. One village from each ward, making four villages in total, was randomly selected.

Table 5.2: Number of sampled households and groundwater points in the study villages

Village	Groundwater sources/points	Total households (N)	Sample households (n)	Per cent
Welela	6	210	78	31
Tagamenda	4	186	69	28
Kidegembye	7	154	58	23
Kichiwa	5	120	45	18
Total	**22**	**670**	**250**	**100**

Simple random sampling was used to select household respondents whereby the heads of household and or spouses were interviewed. The plan was to interview equal numbers of male and female respondents because they are both beneficiaries but possibly with different perspectives on compliance with groundwater institutions. When a household head was interviewed the next respondent had to be a spouse, and so on, until the required sample size was reached. This gave an equal number of male and female respondents. The Yamane (1967) formula was used to estimate the total sample size. The formula was used because the population size was known. According to Louangrath and Sutanapong (2019), this formula is useful when the population size is known. The Yamane formula is expressed as:

$$n = \frac{N}{1+N(e)2} \quad \text{…….. (2)}$$

Where:

n = the sample size;

N = the population size, and

e = the level of precision.

Substituting the 670 total households and 0.05 level of precision into equation 1, we get the sample size of 250 that is:

$$\frac{670}{1+670(0.0)2} n = 250.47 \approx 250$$

Proportionate sampling was employed, using the following formula, in order to ensure that the number of sampled households in each village was proportional to the total number of households (Kothari, 2006).

$$a = \frac{n}{N*b} \text{……………………………………………………………………………………(3)}$$

Where:

a = sample size for each village,

n = total number of sampled households for 4 villages,

N = target households for 4 villages, and

b = target households in each village.

5.5.3 Data collection methods and tools

A household survey, being guided by a structured questionnaire, was used to collect quantitative data. The questionnaire helped to obtain data related to the respondents' socio-economic and demographic characteristics, levels of groundwater users' compliance and factors influencing groundwater users' compliance with groundwater institutions. The questionnaire was pretested to 15 respondents in a village which was not included in the sample. According to Sheatsley (1983) cited by Zukerburg *et al.* (1994), 12-25 cases in pretesting are sufficient to reveal the major complications and weaknesses of a research tool. The outputs of pretesting were used to refine the questions in the questionnaire.

Focus Group Discussions (FGDs) and key informant interviews were used to generate qualitative data. One FGD was conducted for each village making a total of four FGDs.

Each FGDs comprised 7 to 9 participants mainly groundwater users. This number of FGDs participants was appropriate to allow active participation of the discussants. If the discussants are too many, some of them will just sit idle without contributing ideas, and if they are too few, they may not be able to discuss complex issues (Bryman, 2004; Barbour and Schostak, 2011). A total of 32 participants were involved in FGDs. The proportion of women participants in FGDs ranged from four to six per group. The groups included males and females because, according to URT (2002), both are responsible for groundwater management. Thus, mixed groups helped to obtain views of both males and females. FGDs are useful for generating in depth information through discussion on the topic at hand (Creswell, 2014). A total of nine key informants; mainly leaders from Community Owned Water Supply Organizations (COWSOs), Village Government Authorities (VGAs) and district water officials; were involved in the study. Both FGDs and key informant interviews were guided by checklists of items.

5.5.4 Measurement of the levels of groundwater users' compliance with groundwater institutions

A Summated Index Scale (SIS) with five- point index scale was used to measure the level of groundwater users' compliance with groundwater institutions. The groundwater rules were assigned points based on a five-point scale, that is strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points) and strongly disagree (1 point). The rules used to quantify compliance are listed on Table 5.3.

Table 5.3: Groundwater rules

S/N	Groundwater rules
1	Paying water charges
2	Attending meetings involving discussion on groundwater management
3	Observing prescribed distances from groundwater sources when implementing socio-economic activities

4	Reporting to the COWSO leaders when there is inappropriate behaviour at the water source
5	Protecting groundwater source from pollution
6	Paying penalties when faced with non-compliance

Source: URT (2009) and URT (2019b)

Since the scale generated ordinal data, the median was used as a cut-off point to determine the levels of groundwater users' compliance. Based on the total number of groundwater rules the median score was 18. Since groundwater rules were assigned a five –point scale, thus three points were multiplied by 6 (total number of water rules) in order to obtain the median score. Thus, the summation of scores below the cut-off point ($L_{s,j} < 18$) represents low groundwater users' compliance. The total scores at the cut-off point ($L_{s,j} = 18$) represents medium compliance while the total scores above the median ($L_{s,j} > 18$) represent high groundwater users' compliance. The following equation was used to calculate the level of groundwater users' compliance with groundwater rules.

$$L_{s,j} = \sum_{s,j} \quad \text{.....(5)}$$

Where:

s = number of statements

j = number of respondents (250)

In addition, a Summated Index Scale (SIS) with five points was used to quantify the practice of governance principles. The factors were assigned points based on a five-point scale, that is strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2

points) and strongly disagree (1 point). The governance principles are shown in Table 5.3.

The equation for the SIS is as follows:

$$L_{i,s,j} = \sum_{i,s,j} R \quad \text{.....(6)}$$

Where:

R = scales in form of 1, 2, 3, 4, and 5

i = governance principles: participation, accountability, transparency, efficiency, rule of law, equitability, responsiveness, and collaboration

j = number of respondents (250)

s = number of statements per each governance principle

Table 5.4: Statements used to quantify governance principles

Governance principle	Statements
Participation	(i) Owning property for groundwater management
	(ii) Budgeting resources for groundwater management
	(iii) Allocating groundwater source points
	(iv) Contributing resources for groundwater management
	(v) Formulating by-laws for groundwater management
Accountability	(i) Giving accounting reports
	(ii) Accepting challenges related to groundwater management
	(iii) Accepting challenges from groundwater users
	(iv) Sharing lessons learned on groundwater management
	(v) Explaining openly the rationale for various decisions made
	(vi) Discussing the accounting reports
Transparency	(i) Presenting the agenda of groundwater management in meetings
	(ii) Providing financial statements
	(iii) Allowing criticism from groundwater users
	(iv) Giving or accepting apologies when matters have gone wrong
	(v) Sharing information from various governance structures
	(vi) Knowing all source of funds if any
Equitability	(i) Treating all groundwater users with respect and dignity
	(ii) Both men and women have opportunity of being leaders
	(iii) Encouraging groundwater users to contribute resources
	(iv) Witnessing fair source points allocation
	(v) Involving all people on groundwater management regardless their income differences
	(vi) Involving all people on groundwater management regardless their age differences
Rule of law	(i) Encouraging water payment as agreed
	(ii) Prohibiting all socio activities around groundwater points

	(iii) Giving sanctions to all people who breached water rules regardless their social or economic status
	(iv) Groundwater management focus on issues not on a person
Responsiveness	(i) Timely disseminating the information
	(ii) Repairing groundwater infrastructures timely when they have to be repaired
	(iii) Contributing timely the resources for groundwater management when is needed
	(iv) Groundwater users receive timely groundwater related financial reports
Collaboration	(i) Addressing groundwater management challenges
	(ii) Creating community awareness on groundwater management
	(iii) Encouraging groundwater users to participate on groundwater management
	(iv) Enforcing various by- laws of groundwater management

Adapted from URT (2002), (2009), (2019b)

The One Way Analysis of Variance (ANOVA) was used to compare mean distance in metres from households to the groundwater points. The following formula as used by Ostertagagova and Ostertag (2013) was used to calculate the mean distance.

$$\bar{x_i} = \frac{1}{n_i} \frac{\sum_{j=1}^{n_i} x_{ij}}{n_i} \quad \text{..... (7)}$$

Where:

$\bar{x_i}$ = Mean distance of the i^{th} group (village)

n_i=Number of observations in the i^{th} group (village)

x_{ij}= Value of i^{th} observation at the i^{th} factor level (village)

Furthermore, closed-ended questions were deployed to obtain the respondents' perception on the groundwater quality and availability in groundwater points.

5.5.5 Data analysis

Qualitative data were analysed using content analysis whereby themes and arguments of different interviewees were summarized. SPSS helped to compute frequencies and

percentages which simplified the description and presentation of the quantitative study findings including the respondents' socio-economic and demographic characteristics; groundwater quality and availability; groundwater users' compliance and factors influencing groundwater users' compliance with groundwater institutions.

Ordinal logistic regression was used to determine factors that are likely to influence groundwater users to comply with groundwater institutions. The total scores from the five points that is strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points) and strongly disagree (1 point) were used in the model to find whether the governance principles had an influence on chances of high compliance with institutions. Rating levels of compliance helped to determine the probability of groundwater users falling in the highest tercile of compliance. Data related to accessibility of households to groundwater points, groundwater quality and availability of groundwater were categorised in two groups that is within 400 metres and above 400 metres for accessibility while Yes or No for groundwater quality and availability of groundwater. The following equation was used to determine the influence of factors on compliance with groundwater institutions.

$$Y = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_i X_1 \dots\dots \beta_n X_n + e \quad \text{.....(8)}$$

Where:

y_i = 0 = Low, 1= Medium and 2= High

X_1 = Explanatory variables as shown in Table 4.5

β_i = Coefficient of explanatory variables

e = error term.

From Table 5.5, positive sign means that the explanatory variable under consideration increases the likelihood of the groundwater users to comply with groundwater institutions whereas for the negative sign on the explanatory variable under consideration decreases the likelihood of the groundwater users to comply with water institutions. The ordinal logistic regression model was considered to be appropriate in this case because the dependent variable on level of compliance was ordered, while the independent variables were a mixture of variables which involved nominal and ratio levels of measurements.

Table 5.5: Description of explanatory variables

Variable	Description	Level of measurement	Expected sign
X_1 = Groundwater quality	1 = yes if good quality, 0 = Otherwise	Nominal	+/-
X_2 = Availability of water	1 = yes if always sufficient, 0 = Otherwise	Nominal	+/-
X_3 = Distance	1 = yes if within 400 metres, 0 = Otherwise	Nominal	+/-
X_4 = Accountability	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_5 = Participation	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_6 = Transparency	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_7 = Rule of law	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_8 = Equitability	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_9 = Collaboration	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_{10} = Responsiveness	Individual's perception based on the total scores from the five-point scale	Ratio	+
X_{11} = =Efficiency	Individual's perception based on the total scores from the five-point scale	Ratio	+

In addition, Variance Inflation Factor (VIF) test was used to check the existence of multicollinearity in the independent variables. The results showed no multicollinearity in the data set because all of the VIF values were less than 10 and the tolerance ranged between 0.888 and 0. 965. The general rule for VIF test is that, if the VIF value is greater than 10 then there is multicollinearity (Landau and Everitt, 2004; Lee, 2019).

In addition, the general rule for tolerance test is that, if the tolerance value is close to 1 then there is little multicollinearity and if the tolerance is close to zero implies serious multicollinearity (Landau and Everitt, 2004; Senaviratna and Cooray, 2019). Furthermore, Pearson correlation coefficient was used to measure the strength of the association

between two variables whereas the results ranged between -0.018 to 0.723. The general rule for Pearson correlation coefficient test is that, if the Pearson correlation coefficient value is greater than 0.8 then there is multicollinearity (Senaviratna and Cooray, 2019). Therefore, this implies that the explanatory variables that were used in ordinal logistic regression model were not highly correlated with each other. In addition, before data analysis, the Cronbach's Alpha was used to measure the inter-item consistency and reliability of ordinal data. The basic equation to calculate the Cronbanch's alpha value is given as follows:

$$a = \frac{K}{K - 1}\left(1 - \sum \frac{V_i}{V_t}\right) \quad \text{.....(9)}$$

Where:

α = Alpha

K = Number of questions

V_i= Variance of scores on each question

V_t= Total variance of overall scores (Not percentages on the entire test).

The result of the Cronbanch's Alpha value was 0.729 indicating that the scale was reliable. The Cronbanch's Alpha is a common measure to determine how well items in a set are positively correlated to one another. Cronbanch's Alpha value less than 0.6 is considered to be poor while those between 0.7 and 1.0 are considered good (Pallant, 2007). Chi-squire test of association was used to determine whether the respondents' socio-demographic characteristics and the approximate distance from the respondents' households to groundwater points influenced groundwater users' compliance with groundwater institutions.

5.6 Results and Discussion

5.6.1 Respondents' socio-economic and demographic characteristics

Respondents' socio-economic and demographic characteristics are presented in Table 5.6. The results show that 50% of the respondents were females.

Table 5.6: Respondents' socio- economic and demographic characteristics (n=250)

Sex	Welela	Kichiwa	Tagamenda	Kidegembye	Total
Male	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Female	39(50.0)	23(50.0)	34(50.0)	29(50.0)	125(50.0)
Respondents' age					
18-39	30(12.0)	17(6.8)	21(8.4)	24(9.6)	92(36.8)
40-59	41(16.4)	29(11.6)	43(17.2)	28(11.2)	141(56.4)
60 above	7 (2.8)	0(0.0)	4(1.6)	6(2.4)	17(6.8)
Relationship to the household head					
Head of household	38(15.2)	27(10.8)	43(17.2)	35(14.0)	143(57.2)
Spouse	32(12.8)	15(6.0)	22(8.8)	20(8.0)	89(35.6)
Daughter	2(0.8)	0(0.0)	0(0.0)	0(0.0)	2(0.8)
Son	6(7.7)	4(8.7)	3(4.4)	3(5.2)	16(6.4)
Respondents' marital status					
Married	57(22.8)	30(12.0)	45(18.0)	40(16.0)	172(68.8)
Single	4(1.6)	2(0.8)	1(0.4)	1(0.4)	8(3.2)
Divorced	2(0.8)	0(0.0)	0(0.0)	1(0.4)	3(1.2)
Widowed/widower	15(6.0)	14(5.6)	22(8.8)	16(6.4)	67(26.8)
Main source of income of the household					
Farming	65(26.0)	38(15.2)	56(22.4)	48(19.2)	207(82.8)
Business	11 (4.4)	8(3.2)	12(4.8)	10(4.0)	41(16.4)
Salary	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Casual labour	1(0.4)	0(0.0)	0(0.0)	0(0.0)	1 (0.4)
Education level					
No formal education	3(1.2)	0(0.0)	3 (1.2)	2(0.8)	8(3.2)
Primary education	42(16.8)	33(13.2)	58(23.2)	37(14.8)	170(68.0)
Secondary school	21(8.4)	9(3.6)	5(2.0)	16(6.4)	51(20.4)
Tertiary education	12(4.8)	4(1.6)	2(0.8)	3(1.2)	21(8.4)
Respondents' Main occupations					
Farming	70(28.0)	44(17.6)	65(26.0)	56(22.4)	235(94.0)
Small scale business	8(3.2)	2(0.8)	3(1.2)	2(0.8)	14(5.6)
Formal employment	0(0.0)	0(0.0)	0(0.0)	1(0.4)	1(0.4)

Note*: The numbers in brackets are per cents*

The results also show that 57.2% and 35.6% of the respondents were household heads and spouses of the household heads respectively. The rest were other household members. In

relation to age groups, 56.4% of the respondents were 40 to 59 years old. This indicates that the area had a potential labour power of young adults who are essential for socio-economic activities including those related to groundwater management and governance.

In addition, 94% of the respondents depended on farming activities as their main source of income and livelihoods in general. The rest depended on small scale businesses such as tailoring, bricks making, and selling crop products. Literature shows that currently agriculture provides employment about to 66.9% of Tanzanians (URT, 2016b). With regard to the respondents' education level, the results showed that 68% of the respondents had primary education whereas 20.4% had secondary level of education (Table 5.6). This implies that the majority had acquired basic education. This level of education can help the majority to access adequate information on various socio-economic activities including groundwater management activities.

The results in Table 5.7 shows respondents' age, household size, total number of years a household had been residing in the village and household annual income. The results show that the mean age of the respondents was 43 years. This implies that the majority of the respondents were adults who are expected to have high awareness of water institutions. Furthermore, the mean number of persons per household was 5.6. This number is above 4.7 persons reported at the national level (URT, 2017) as well as 4.2 persons reported at the district level (URT, 2012). With regard to the total number of years for which respondents had been residing in the villages, the results show that the mean number was 41 years. This suggests that the majority had enough experience with groundwater issues in the study area.

Table 5.7: Some socio-demographic characteristics (n=250)

Variable	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	23	78	43.0	11.8

Years of schooling of the respondent	0	13	8.1	2.5
Total number of the people in the household	3	9	5.6	1.3
Total number of years residing in the village	12	60	41.0	10.8
Annual income of the household from the main source of income	225 000	13 700 000	3 468 982	3 181 766.7

5.6.2 Descriptive statistics for groundwater quality and availability

Table 5.8 presents the respondents' perception on the groundwater quality and availability. The results showed that 88% of the respondents agreed that groundwater had good quality in terms of taste and colour whereas 83.2% of the respondents reported that groundwater was sufficient throughout the year at the groundwater points.

Table 5.8: Respondents' perception on groundwater quality and availability in percentages (n=250)

Variable	Yes	No
Quality (Good)	220(88.0)	30(12.0)
Availability (Sufficiency)	208 (83.2)	42(16.8)

Note*: Numbers in brackets are percentages*

This suggests that groundwater was valuable resource for human consumption. Literature shows that groundwater is the most reliable water resource to support community livelihoods (Nganyanyuka, 2017; Ngasala *et al*., 2018; Mussa *et al*., 2019). However, groundwater in some parts of Tanzania is of poor quality due to various factors including pollution caused by human activities (Sappa and Lucian, 2014; Arduino *et al*., 2012; Komakech and Bont, 2018).

5.6.3 Descriptive analysis of levels of governance principles

The descriptive analysis of levels of governance factors are presented in Table 5.9.

Table 5.9: Levels of governance principles practice

Governance principle	Level of governance	n	Mean rank	Median
Participation	Low	64	40.95	
	Medium	49	84.47	15
	High	137	179.67	
	Total	250		
Transparency	Low	207	244.00	
	Medium	30	104.00	
	High	13	222.50	18
	Total	250		
Accountability	Low	184	232.50	
	Medium	36	92.84	
	High	30	197.40	18
	Total	250		
Equitability	Low	33	105.00	
	Medium	8	213.50	18
	High	209	234.00	
	Total	250		
Rule of law	Low	83	63.14	
	Medium	123	208.64	12
	High	44	143.00	
	Total	250		
Responsiveness	Low	159	81.99	
	Medium	36	171.90	12
	High	55	220.91	
	Total	250		
Efficiency	Low	75	39.96	
	Medium	45	100.77	12
	High	130	183.41	
	Total	250		
Collaboration	Low	157	223.53	
	Medium	53	79.80	12
	High	40	175.00	
	Total	250		

Low = 0, Medium =1, and High =2

Looking at the column of mean rank, the results show high level of governance in participation, equitability, and efficiency. The mean ranks of the rest of governance principles were low implying that those governance principles had low chance of influence on compliance with groundwater institutions.

5.6.4 Compliance with groundwater institutions

Table 5.10 presents compliance with groundwater institutions. Looking at the column of high compliance, the results showed that most groundwater users complied with the institution of protecting groundwater points.

Table 5.10: Respondents' responses on compliance with groundwater rules (n=250)

Statement	Low	Medium	High
Paying contributions when needed	52(20.8)	148(59.2)	50(20.0)
Attending in meetings involving discussion on groundwater management	22 (8.8)	153(61.2)	75(30.0)
Observing prescribed distances from groundwater sources when implementing socio economic activities	110(44.0)	87(30.8)	53(21.2)
Reporting to the COWSO leaders when there is inappropriate behavior at the water source	11(4.4)	161(64.4)	78(31.2)
Protecting groundwater source from pollution	15(6.0)	73(29.2)	162(64.8)
Paying penalties when faced with non-compliance	131(52.4)	49(19.6)	70(28.0)

Note: *The numbers in brackets are per cents*

Other institutional issues such as paying contributions when needed, attending meetings that involved discussions of groundwater issues and reporting to the governance actors when observed inappropriate behaviour at the water points were not complied highly with by fewer respondents (Table 5.10). This suggests variation of groundwater users' compliance with groundwater rules whereas a larger proportion showed medium compliance.

Qualitative results showed that non-compliance with groundwater institutions and paying penalty were explained by poor transparency of the governance actors particularly on financial matters. This indicates that groundwater users may comply with groundwater institutions when they are informed about groundwater management. Furthermore, a

COWSO key informant in Kichiwa village reported that the majority of household members did not attend meetings to discuss issues about groundwater management. This is in line with the following quotation: "*Most of groundwater users do not attend public meetings that we normally conduct to discuss about groundwater management*". This shows poor responsibility among groundwater users. It can also be interpreted as poor accountability among groundwater users for matters related to groundwater. Previous studies showed that groundwater users in some parts of Tanzania had little compliance with groundwater institutions due to various reasons including lack of transparency on financial issues and poor communication between water governance structures (Mandara *et al.*, 2013; Mandara, 2014; Comte *et al*., 2016).

5.6.5 Level of compliance with groundwater institutions

The results showed that 54.4% of the respondents perceived medium compliance with groundwater institutions (Figure 5.3). Quantitative data were in line with the qualitative data. Both key informants and FGDs expressed medium groundwater users' compliance with the groundwater institutions. For instance, COWSOs in Kichiwa and Tagamenda villages reported that the majority of the groundwater users partially complied with groundwater institutions particularly in paying penalties and contributing money for maintenance of pumps when needed. Based on the qualitative data, medium level of groundwater users' compliance with groundwater institutions was attributed to various factors including establishment of wells owned by households. During FGDs and key informant interviews in all villages it was reported that there was an increase of groundwater users who establish their own shallow wells around their households. Such tendency makes the owners of those wells to become less active in taking responsibilities for public groundwater projects particularly on issues that involve payments.

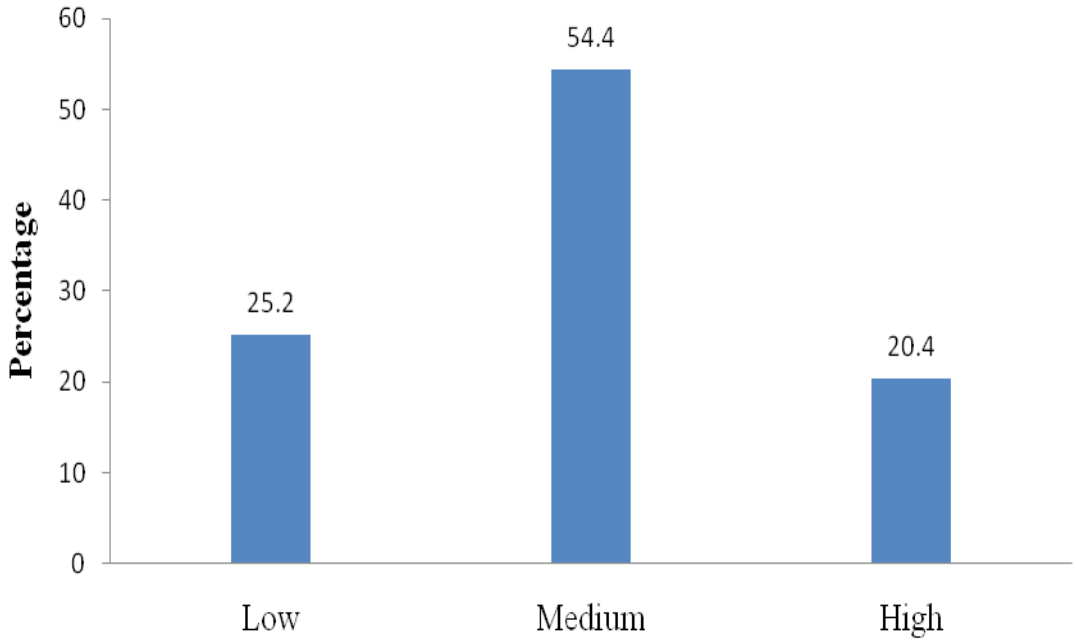

Figure 5.3: Level of groundwater users' compliance with groundwater institutions

Curiously, one may raise a question on whether households that have established own groundwater sources get legitimacy of being free from taking responsibilities for public groundwater points. The National Water Policy (URT, 2002) shows that water, including groundwater, is a public resource that should be collectively managed by the entire community. Therefore, limited groundwater users' compliance with groundwater institutions for those who own groundwater sources caused ineffective groundwater management particularly in the public groundwater points in the study area.

5.6.6 Influence of groundwater governance and management on compliance with groundwater institutions

Table 5.11 shows factors that influenced groundwater users' compliance with groundwater institutions in the study area. Based on the ordinal logistic regression analysis, compliance was mainly influenced by availability of groundwater (Wald = 7.694, p =0.006), quality of groundwater (Wald = 20.408, p = 0.000) and participation (Wald = 13.397, p= 0.000).

Table 5.11: Factors influencing compliance with groundwater institutions (n=250)

Variable	Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Participation	1.001	.274	13.397	1	.000	1.537	.465
Collaboration	.074	.350	.045	1	.832	-.613	.761
Groundwater quality	2.191	.485	20.408	1	.000	1.240	3.141
Transparency	.452	.339	1.780	1	.182	-1.116	.212
Responsiveness	.202	.261	.599	1	.439	-.310	.714
Equitability	.080	.270	.087	1	.768	-.450	.610
Efficiency	.442	.291	2.317	1	.128	-.127	1.012
Availability of water	1.340	.483	7.694	1	.006	.393	2.287
Rule of law	-.842	.494	2.902	1	.088	-1.811	.127
Accountability	.702	.501	1.968	1	.161	-.279	1.683

Note: Model Summary: Cox and Snell $R^2 = 0.189$, Nagelkerke $R^2 = 0.139$: Model fitting information: Chi-square 52.452 ($p<0.000$).

The positive signs of explanatory variables in the estimate column suggest that increase of participation, quality of water and availability of groundwater increased the likelihood of compliance with groundwater institutions while the decrease of distance from households to groundwater points increased the likelihood of compliance with groundwater institutions. Other independent variables including accountability, transparency, rule of law, responsiveness, collaboration and equitability did not show significant influence on the likelihood of households falling into compliance ($p>0.05$). This suggests that most of the governance principles did not influence compliance with groundwater institutions.

5.6.6.1 Participation in decision making

The results in Table 5.11 showed that participation showed statistically significant influence ($p= 0.000$) on chances of compliance with institutions. This connotes that participation of groundwater users in decision making triggers compliance with the groundwater rules. The results correspond with the information gathered during key

informant interviews. In Welela Village, for instance, it was stated that groundwater users complied because COWSO leaders encouraged groundwater users to participate in decision making related with groundwater management. Certainly, participation of groundwater users in owning property items, budgeting resources, allocating groundwater points, and formulating by-laws for groundwater management motivates groundwater users to comply with groundwater institutions. Literature shows that community participation in decision making related to groundwater management activities accelerates community compliance with groundwater institutions (Comte *et al*., 2016; Kabogo *et al*., 2017; Mandara *et al*., 2017).

5.6.6.2 Groundwater quality

The concept of groundwater quality is broad; Ojo and Otieno (2012) define groundwater quality as physical, chemical and biological qualities of groundwater. Also, it involves temperature, turbidity, purity and taste. Some groundwater quality aspects such as physical, chemical and biological qualities, temperature and turbidity of groundwater are scientifically determined. Others including taste, purity and volume can be perceived by the groundwater users. In this study, groundwater quality refers to the taste and purity of groundwater at a particular groundwater point based on groundwater users' perception. During FGDs, it was explained that groundwater had a favourable taste and was clean enough for domestic use. This was also reported by a key informant in Kidegembye Village: "*In our village we have 7 public groundwater points which provide clean water with a good taste all seasons*", said the VEO in Kidegembye village. Certainly, the good quality of groundwater is explained by protection of groundwater points in the study area. Literature, including Comte *et al*. (2016) and Gudaga *et al.* (2018a) showed that groundwater in some parts of Tanzania is of good quality and safe for domestic uses.

5.6.6.3 Groundwater availability

The ordinal regression results showed that availability of groundwater in the study area had significant influence on compliance with groundwater institutions (Table 5.11). During FGDs, it was found that all groundwater points provided sufficient volume of groundwater throughout a year. This is in line with the following quotation:

> "Groundwater *is the only source of water for domestic purposes in our village. And we are so lucky that always groundwater points provide sufficient water unless otherwise a water point has been devastated. Thus, we normally emphasize to people to maintain these groundwater facilities for further use"* (COWSO leader in Welela village).

This implies that groundwater users were self-motivated to comply with groundwater rules because groundwater was the only reliable source of water in the study area. Previous studies showed that groundwater users who mainly depend on groundwater sources have high compliance with groundwater rules including protecting sources and paying water charges as collectively agreed by them (Gudaga *et al*., 2018; Musa *et al*., 2019).

5.6.6.4 Distance from households to groundwater points

The results from the Chi-squire test shown in Table 5.12 shows statistically significant association between the distance from households to the groundwater points and the groundwater users' compliance with groundwater institutions ($p = 0.006$). The results showed that the number of groundwater users who stayed within 400 metres from their households to groundwater points had higher level of compliance than those who stayed above 400 metres from their households to groundwater points. It is clear that the acceptable distance from households to groundwater points reduced the time used to

collect groundwater from the points. To that effect, groundwater users complied with groundwater institutions including protecting groundwater sources. In addition, the accepted distance from households to groundwater sources can enable the groundwater users to observe easily environmental situation of the groundwater points as well as any inappropriate behaviour that can be undertaken at the groundwater points. In 2015, about 68.9 % of Tanzanian population in rural areas were getting water within the recommended accessible distance (Tanzania Water and Sanitation Network, 2019; URT, 2020).

Table 5.12: Respondents' socio-demographic factors in relation with their compliance with groundwater institutions (n=250)

Factor associated with compliance		Levels of compliance				Chi-Squire Test		
		Low	Medium	High	Total	Value	df	Asymp. Sig. (2-sided)
Estimated distance from home to groundwater points	400 metres below	55	73	91	219	30.119	2	.006
	Above 400 metres	21	9	1	31			
	Total	**76**	**82**	**92**	**250**			

5.6.6.5 Socio-demographic factors influencing groundwater users' compliance with groundwater institutions

Table 5.13 presents socio-demographic factors of the respondents that influenced groundwater users' compliance with groundwater institutions in the study area. Based on the Chi-square test of association, compliance was mainly influenced by sex ($p = 0.000$) and education level ($p = 0.000$) of the respondents. Other factors including age and relationship with the household head were statistically not significant at 5% of significance level. This suggests that the age of the respondents and their relationship with the household heads did not influence significantly groundwater users to comply with

groundwater institutions. The results showed that female complied highly with groundwater institutions than male.

Table 5.13: Respondents' socio-demographic factors in relation with their compliance with groundwater institutions (n=250)

Factors associated with compliance		Levels of compliance				Chi-Squire Test		
		Low	Medium	High	Total	Value	df	Asymp. Sig. (2-sided)
Sex	Male	35	80	10	125	29.570	2	.000
	Female	34	37	54	125			
	Total	**69**	**47**	**134**	**250**			
Education level	Standard seven below	85	46	47	178	28.854	2	.000
	Secondary school above	9	25	38	72			
	Total	**94**	**71**	**85**	**250**			
Age	Between 18-39 yrs	14	32	46	92	1.232	4	.873
	Between 40-59 yrs	21	46	74	141			
	60 yrs above	4	6	7	17			
	Total	**39**	**158**	**53**	**250**			
Relationship with the household head	Household head	20	92	35	147	2.077	2	.354
	Others	19	66	18	103			
	Total	**39**	**158**	**53**	**250**			

High level of compliance of female can be associated with gender roles particularly on collecting water from water sources for various purposes including domestic use. During FGD in Kichiwa village it was expressed that female are the most responsible ones to collect water from groundwater sources. This is in line with the following quotation: "*...according to the customs of Bena tribe in Njombe district, it is unusual for male to collect water from the water source, it is normally done by female or children from a*

particular household". This suggests that female have a greater chance of implementing groundwater institutions particularly protecting groundwater source from pollution than male. Eventually, the custom which prevents males to collect water from water sources constrains males to practice some groundwater management activities. Literature including Mandara (2014) and Ngasala (2019) show that the role of collecting water from various sources in African context is mainly carried out by female.

Also the results in Table 5.13 show that the majority respondents at the group of those who had secondary school education level and above reported high level of compliance with groundwater institution. On another hand, the majority respondents at the group of those who had standard seven education level and below reported low level of compliance with groundwater institution. This implies that the respondents who had high education preferred to comply with groundwater institutions than those respondents with low education level. Also, it connotes on the importance of formal education because it enlightens the community on environmental issues including groundwater issues. It is clear that through education the individuals become more knowledgeable on the nature of the resource, proper use of the resource, the importance of managing the resource and ways of managing the resource, among others. Comte *et al*. (2016) argued that community members having adequate knowledge on groundwater resource are more willing to engage on groundwater management activities.

5.6.6.6 Other socio-demographic factors influencing groundwater users' compliance with groundwater institutions

Table 5.14 shows other socio-demographic factors that influenced groundwater users' compliance with groundwater institutions in the study area. Using the Chi-square test of

association, the results revealed that the households' annual income of the respondents influenced significantly the groundwater users' compliance with groundwater institutions in the study area (p = 0.01).

Table 5.14: Other respondents' socio-demographic factors in relation with their compliance with groundwater institutions (n=250)

Factors associated with compliance		Level of compliance				Chi-Square Test		
		Low	Medium	High	Total	Value	df	Asymp. Sig. (2-sided)
Household size	Six people and below	9	54	16	79			
	Six people and above	30	104	37	171	1.845	2	.398
	Total	**39**	**158**	**53**	**250**			
Households' annual income	3 468 982 Tshs below	33	76	16	125			
	Above 3 468 982 Tshs	55	15	55	125	28.899	2	.012
	Total	**88**	**91**	**71**	**250**			
Main source income	Farming	33	123	51	207			
	Others	11	19	13	43	11.867	2	.152
	Total	**44**	**142**	**64**	**250**			
Marital status	Married	29	111	32	172			
	Others	10	47	21	78	2.468	2	.291
	Total	**39**	**158**	**53**	**250**			

Other independent variables such as household size, main source of income and marital status were statistically not significant at 5% of significance level. This implies that the variables did not influence groundwater users to comply with groundwater institutions significantly.

The results showed that the majority respondents who earned 3 468 982 Tshs and above had higher level of compliance compared the respondents who earned below 3 468 982

Tshs annually. This implies that people with high income are likely to comply with groundwater institutions particularly those involve payments. This idea corresponds with the explanations that were given by COWSO' key informant at Welela village: He said "*….one of the challenges that we meet in our COWSO is that, there are few groundwater users who fail to contribute money for maintenance of groundwater points when is needed because of poor financial position*". This suggests the importance of maintaining and/or improving the economic status of groundwater users at the household level. This will further enhance groundwater users to engage actively on groundwater management including to pay financial contributions when needed. Evidence from the study conducted by Masanyiwa *et al*. (2017) along the shores of Lake Victoria shows that close to half of the households (48%) had limited access to domestic water supply due to unaffordability to pay for the water services.

Overall, the findings from the present study demonstrate average groundwater users' compliance with groundwater institutions. Certainly, average compliance with institutions constrained the effectiveness of groundwater governance and management in the study area. Therefore, the study concurs with the NIT which emphasises on sufficient compliance with institutions for effective policy implementation. In addition, the study findings showed that all groundwater characteristics and one governance principle namely participation influenced groundwater users to comply with institutions significantly. Thus, the Contextual Interaction Theory which claims that motives are vital to influence individuals' compliance with institutions including groundwater institutions remains ascertained.

5.7 Conclusions and Recommendations

The objective of this paper was to determine influence of governance principles practice, socio-demographic characteristics of groundwater users and groundwater characteristics

on compliance with groundwater institutions at a local level in Njombe District. The study concludes that groundwater characteristics, the practice of governance principles particularly participation in decision making, accessibility of groundwater, and socio-demographic characteristics are essential aspects to influence groundwater users' compliance with groundwater institutions.

On the basis of the conclusions, it is recommended that groundwater governance actors; including the district water officials, village councils and COWSO leaders; should practice well the good governance principles in the study area. Also the study recommends that local government authority and other water development stakeholders should increase number of groundwater points within the recommendable distance. Furthermore, the groundwater users' socio-demographic characteristics particularly sex, education level and households' income of the groundwater users should be considered by groundwater governance actors to enhance effective groundwater management at the local level. This will further increase the level of compliance with groundwater institutions.

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CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Groundwater governance principles

The first specific objective was to explore the practice of the governance principles among groundwater governance actors. The study concludes that some governance principles were poorly practised while a few were well practised. Three governance principles that were well practised include participation, equitability and efficiency. Transparency, accountability, rule of law, responsiveness, and collaboration were poorly practised. It is clear from the discussion that groundwater management was poor because of the poorly practised governance principles. The relationship between COWSOs and Village Councils and poor understanding of governance principles among COWSOs and Village Councils' actors explain the poor practice of groundwater governance principles.

6.1.2 Levels of groundwater governance

The specific objective number two was to establish groundwater governance in the study area using governance principles. The study concludes that the overall level of groundwater governance in the study area was low. Furthermore, compliance with governance principles and nature of the existing relationships among groundwater governance actors at the village level differed by locality and hence differential levels of groundwater governance across localities. In this regard, higher groundwater governance levels were recorded in villages where groundwater governance actors complied well with governance principles, and hence supporting the Theory of Good Governance. It is therefore concluded that, groundwater governance levels differed by localities.

6.1.3 Interactions among groundwater governance actors

The third specific objective of this study was to explore interactions among groundwater governance actors. The study concludes that groundwater governance actors were established and worked in line with NAWAPO directives. In addition, groundwater governance structures interacted well among themselves particularly in sharing information related to groundwater governance and management in the district. Also, this paper concludes that poor control over information flow among governance structures constrained the intended groundwater governance hence causing ineffective groundwater management in the study area.

6.1.4 Compliance with groundwater institutions

The last specific objective of this study was to determine factors that influenced compliance with groundwater institutions. The study concludes that groundwater characteristics in terms of the quality and its availability , the practice of governance principles particularly participation in decision making, accessibility of groundwater, and socio-demographic characteristics are essential aspects to influence groundwater users' compliance with groundwater institutions.

6.2 Recommendations

Based on the above conclusions the study recommends the following:

(i) The District authority and other related stakeholders should establish mechanisms to provide capacity buildings to groundwater governance structures particularly to the COWSOs or CBWSOs officials on how they can practice effectively all the governance principles for groundwater management. Such capacity building will strengthen the performance of groundwater governance officials because they will be

more aware on groundwater governance matters including the practice of governance principles for effective groundwater management at a local level.

(ii) Groundwater governance actors particularly COWSOs leaders should practice effectively all governance principles with emphasis on those currently poorly practiced so as to raise the level of groundwater governance for groundwater management in the study area. In addition, the study recommends that the groundwater governance structures at the district level especially RUWASA officials should try for their level best to conduct supervisions and provide capacity building on groundwater governance matters to all COWSOs or CBWSOs officials in all villages of the district. This will help to improve the performance of COWSOs or CBWSOs actors particularly in practicing the governance principles for effective groundwater management in the district.

(iii) Groundwater governance structures should further develop and maintain the current interaction for groundwater management in the district. This will help to improve groundwater governance by sharing experience, resources and knowledge on various groundwater management issues in the district. In addition, the study recommends that the Ministry of Water should provide capacity building related with interactions particularly on efficient control of information flow and linking other governance structures for groundwater governance and management matters at a local level. This will facilitate the accessibility and availability of information or resources that are imperative for effective groundwater governance at the local level.

(iv) The study recommends that groundwater governance actors including the district water officials, village councils and COWSO leaders should practice well the good governance principles in the study area. Also the study recommends that local government authority and other water development stakeholders should increase number of groundwater points within the recommendable distance. Furthermore, the groundwater users' socio-demographic characteristics particularly sex, education level and households' income of the groundwater users should be considered by groundwater governance actors to enhance effective groundwater management at the local level. This will increase the level of compliance with groundwater institutions.

6.3 Theoretical Reflections

In relation to the theoretical reflections, the study concurs with all four theories namely Good Governance Theory, New Institution Theory, Contextual Interaction Theory and Policy Network Theory that were used to guide this study. Based on the Good Governance Theory the study agrees that the practice of good governance principles is a vital aspect to enhance effective resource management including groundwater. This argument is supported by results of the study whereby the majority governance principles were poorly practiced by the groundwater governance actors. As results, the overall groundwater governance level was low in the study area.

In addition, the study concurs with the New Institution Theory which emphasizes on the importance of actors' compliance with the institutions of a particular organization. Since the overall level of groundwater users' compliance with groundwater institutions was medium, probably medium level of compliance affected the level of groundwater governance in the study area. Thus, the study asserts on the importance of groundwater

users' compliance with groundwater institutions in order to achieve effective groundwater management.

Furthermore, the study corresponds with the Contextual Interaction Theory which argues that individuals normally comply with the institutions if they are motivated by some factors that drive them to take actions. Since the results have shown that groundwater users were mainly influenced by the respondents' socio-demographic characteristics particularly sex, education level and household annual income; accessibility to groundwater, availability of groundwater, quality of groundwater and participation then the study confirms the Contextual Interaction Theory' argument that motives are imperative things for individuals to take actions including for groundwater management.

Lastly, the study is in line with the Policy Network Theory which features the importance of interaction among various actors inside or outside the structure by sharing resources, information and experience among others to solve public policy problems. Apart of the existing interactions of groundwater governance structures yet the study found that most of groundwater governance structures did not link well with others or control cordially the flow of information from one structure to others. It is clear that poor control of flow of information from one structure to another can constrain the actors' interactions hence poor groundwater governance and management. Therefore, the study asserts that adequate interactions of the governance actors are an essence to enhance effective groundwater governance for groundwater management.

6.4 Contribution of the Study to the Body of Knowledge

The contribution of this study to the body of knowledge is shown by confirming the arguments of all the four theories that were used in the study. Firstly, the study asserts the

argument of the Good Governance Theory by emphasizing the importance of practicing well the governance principles to attain effective groundwater governance for groundwater management in a particular locality. Secondly, the study also confirms the argument of the New Institution Theory on the importance of an individuals' compliance with a given institutions. In groundwater governance perspective, the study necessitates on groundwater users' compliance with groundwater institutions to achieve effective groundwater management. Thirdly, the study confirms the Contextual Interaction Theory which argues that the individuals' behaviour is driven by various factors to take actions. Since the results have shown that groundwater users were mainly influenced by the respondents' socio-demographic characteristics particularly sex, education level and household annual income; accessibility to groundwater, availability of groundwater, quality of groundwater and participation then the study confirms that motives are imperative for individuals to take actions including for groundwater management. Lastly, the study confirms the explanations of the Policy Network Theory on the importance of good interactions among actors by sharing resources, information and experience among others to solve public policy problems.

6.5 Areas for Further Study

The assessment of groundwater governance was intended to be analysed using the governance principles in the district. The results showed low level of groundwater governance. This calls for further thoroughly empirical study on the factors that affecting groundwater governance at the local level. Furthermore, the study calls for further study on factors that influence and/or affect interactions among groundwater governance actors at the local level. This will help the groundwater governance actors to come up with further initiatives to improve groundwater governance for groundwater management at the local level.

APPENDICES

Appendix 1: Square matrix used by key informants to identify groundwater governance structures that interacted in the study area

Governance structure	**RUWASA**	**Rufiji River Basin Office**	**District council**	**SHIPO**	**UVINJO**	**Welela VC**	**Kichiwa VC**	**Tagamenda VC**	**Kidegembye VC**	**COWSO Welela**	**COWSO Kichiwa**	**COWSO Tagamenda**	**COWSO Kidegembye**
RUWASA													
Rufiji Water Basin													
District council													
SHIPO													
UVINJO													
Welela VC													
Kichiwa VC													
Tagamenda VC													
Kidegembye VC													
COWSO Welela													
COWSO Kichiwa													
COWSO Tagamenda													
COWSO Kidegembye													

Appendix 2: A copy of household questionnaire used in the research

SOKOINE UNIVERSITY OF AGRICULTURE

COLLEGE OF SOCIAL SCIENCES AND HUMANITIES DEPARTMENT OF DEVELOPMENT STUDIES, P. O. BOX 3024, MOROGORO

A Household Questionnaire for a PhD Research on Groundwater Governance and Management in Njombe District, Tanzania

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By

Johnson L. Gudaga, PhD Student

My name is Johnson L. Gudaga, a PhD student at Sokoine University of Agriculture, Morogoro, Tanzania. This interview is part of a study on "Groundwater governance and management in Njombe District, Tanzania". I would like to ask you some questions related to performance of groundwater governance structures in enhancing groundwater management. In addition, I would like to ask you on your compliance with groundwater institutions. The interview will take about 30 minutes. The information you give will be confidential and only used for the purpose of this PhD research study. Therefore, please be free to give me your views and opinions truthfully.

Section A: Background Information

Respondents' Demographic and Socio-economic Characteristics

Questionnaire No……..Date of Interview…….

Division……Ward……..Village……

Interviewer's name……..

1. Name of household head……
2. Name of respondent……...
3. Relationship with the household head ----------[1=Head of Household 2=spouse, 3=son ,4 Daughter,5= other (specify)----------]
4. Age of the respondent …….
5. Sex of the respondent……. [1=Male, 2=Female]
6. Marital status of respondent …… [1=Married, 2=Single, 3=Divorced, 4=Widowed/Widower, 5= other (specify)----------]
7. Level of education of respondent……. [1= No formal education 2=Adult education, 3=Primary education, 4=Secondary, 5= tertiary education
8. Years of schooling of respondent----------
9. What is the total number of the people in the household?.....
10. Total number of years the household resided in the village----------years
11. Main occupation of the respondent

Main occupation	
Farming	
Livestock keeping	
Small scale business	
Other (specify)	

12 The main source of income of the household

Farming	
Business	
Salary	
Casual labour	
Other (specify)	

13. What other sources of income of the household----------, ----------? -------
14. Estimate of household annual income per year from all sources ----------

SECTION B. Groundwater Information

15. What type of groundwater source does your household depend?

    [1] Deep well [ ]

[2] Shallow well [ ]

16. In which period do you depend on groundwater source?

    [1] Dry season ( )

    [2] Rainy season ( )

    [3] Throughout a year ( )

17. What other source of water your households use? (*Multiple answers are accepted*)

    Rainwater collection ( ) Canal ( ) River ( ) ( ) Other (specify)----------

18. What is the estimate distance from your household to groundwater point? ---- meters

19. How about availability of groundwater at a groundwater point.

    [1] Always available [ ]

    [2] Sometimes available [ ]

    [3] Not available at all [ ]

20. How do you perceive on groundwater quality in terms of taste and purity of at a groundwater point?

    [1] Good [ ]

    [2] Not good [ ]

SECTION C: Water governance information

The following question is intended to investigate your perception on the extent to which groundwater governance structures implement their roles for groundwater management. Thus, you are required to respond by choosing one of the indicated levels of performance for the prescribed directives.

Prescribed directives	**Extent of performance 5=Strongly Agree,4=Agree, 3=Neutral, 2 =Disagree, 1= Strongly disagree**
Participation	
Budgeting resources for groundwater management	
Allocating groundwater source points	
Contributing resources for groundwater management	
Formulating by-laws for groundwater management	
Women participate actively in decision making on groundwater management	
Accountability	
Giving accounting reports	
Accepting challenges related to groundwater management	
Accepting challenges from groundwater users	
Sharing lessons learned on groundwater management	
Explaining openly the rationale for various decisions made	
Discussing the accounting reports	
Transparency	
Presenting the agenda of groundwater management in meetings	
Providing financial reports	
Allowing criticism from groundwater users	
Giving or accepting apologies when matters have gone wrong	
Sharing information from various governance structures	

Knowing all source of funds if any	
Equitability	
Treating all groundwater users with respect and dignity	
Both men and women have opportunity of being leaders	
Encouraging groundwater users to contribute resources	
Witnessing fair source points allocation	
Involving all people on groundwater management regardless their income differences	
Involving all people on groundwater management regardless their age differences	
Efficiency	
Protecting groundwater points against pollution	
Mutual respect among groundwater users to access water	
Groundwater points are nearly allocated at the household	
Availability of groundwater	
The rule of law	
Paying the number of contributions as agreed	
Prohibiting socio-economic activities around groundwater points	
Giving sanctions to all people who breached water rules regardless their social or economic status	
Groundwater management focus on issues not on a person	
Responsiveness	
Timely disseminating the information	
Repairing groundwater infrastructures timely when they have to be repaired	
Contributing timely the resources for groundwater management when is needed	
Groundwater users receive timely groundwater related financial reports	
Collaboration	
Addressing groundwater management challenges	
Creating community awareness on groundwater management	
Encouraging groundwater users to participate on groundwater management	
Enforcing various by- laws of groundwater management	

SECTION D: Compliance with groundwater institutions

The following question is intended to investigate your compliance with groundwater institutions. Thus, you are required to respond by choosing one of the indicated levels of compliance with groundwater institutions.

S/N	**Groundwater rules**	**Extent of compliance 5=Always, 4=Usually, 3=Sometimes, 2 =Rarely, 1= Never**
1	Paying water charges	
2	Attending meetings involving discussion on groundwater management	
3	Observing prescribed distances from groundwater sources when implementing socio-economic activities	
4	Reporting to the COWSO leaders when there is inappropriate behaviour at the water source	
5	Protecting groundwater source from pollution	
6	Paying penalties when faced with non-compliance	

Appendix 3: A copy of check list for Focus Group Discussion (groundwater users)

1. What is the situation of groundwater in the place?
2. What are the groundwater institutions for groundwater management?
3. Are they useful in governing groundwater resources? Why
4. How groundwater users adhere to governance institutions?
5. What challenges occur during implementation of the institutions?
6. How are they handled?
7. What are your opinions on groundwater governance (institutions and structures)

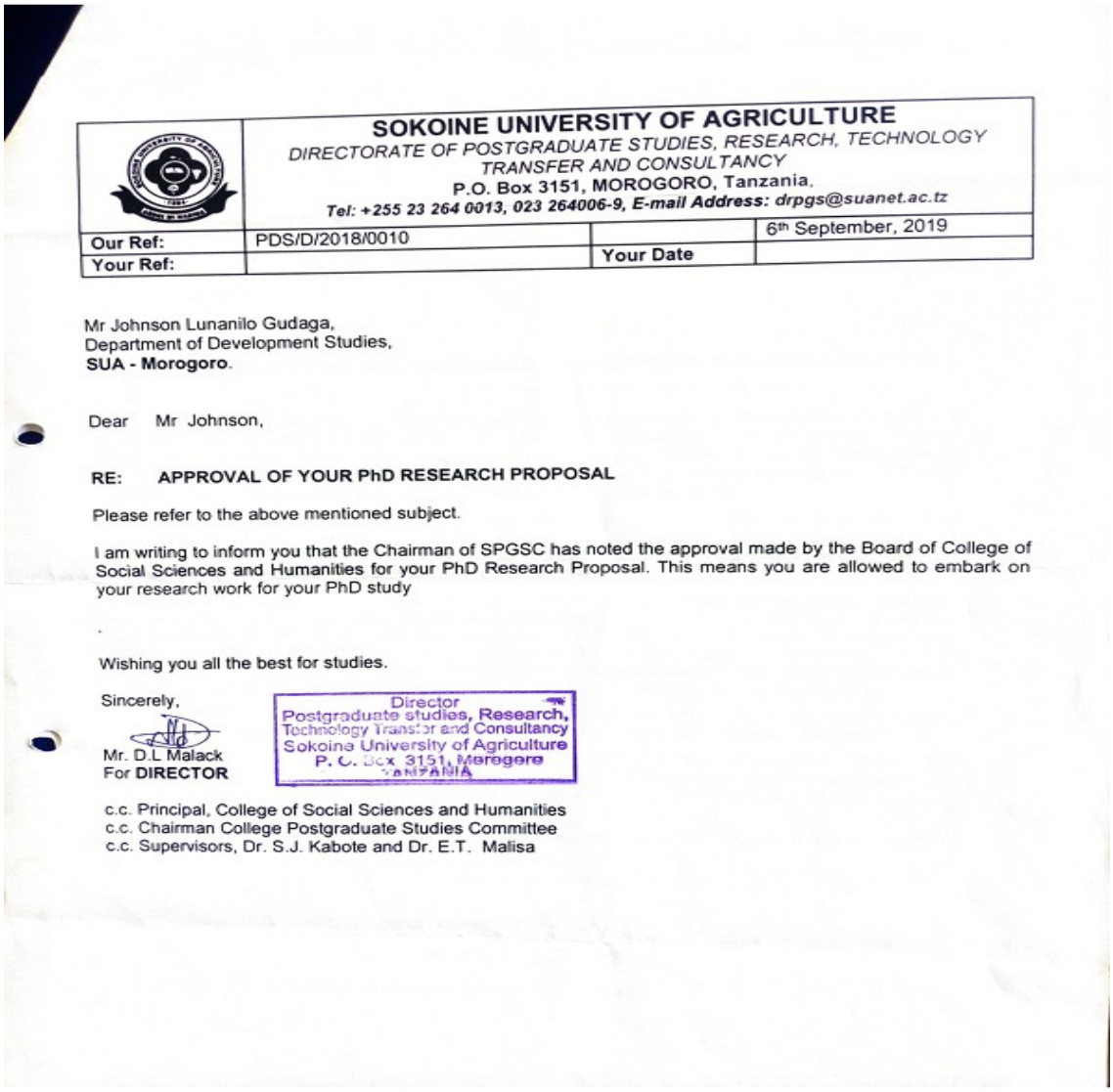
Thank you so much for your assistance and cooperation

Appendix 4: A copy of check list for key informants

1. What is the situation of groundwater management in the place?
2. What are the objectives of governance structure related to groundwater resource management?
3. What are the functions of governance structure related to groundwater management?
4. What mechanism is there to ensure groundwater is managed fairly, efficiently and sustainably?
5. In what ways are the structures linked with other authorities at different levels?

Thank you so much for your cooperation

Appendix 5: Approval for PhD proposal



SOKOINE UNIVERSITY OF AGRICULTURE
DIRECTORATE OF POSTGRADUATE STUDIES, RESEARCH, TECHNOLOGY TRANSFER AND CONSULTANCY
P.O. Box 3151, MOROGORO, Tanzania.
Tel: +255 23 264 0013, 023 264006-9, E-mail Address: drpgs@suanet.ac.tz

Our Ref:	PDS/D/2018/0010		6th September, 2019
Your Ref:		**Your Date**	

Mr Johnson Lunanilo Gudaga,
Department of Development Studies,
SUA - Morogoro.

Dear Mr Johnson,

RE: APPROVAL OF YOUR PhD RESEARCH PROPOSAL

Please refer to the above mentioned subject.

I am writing to inform you that the Chairman of SPGSC has noted the approval made by the Board of College of Social Sciences and Humanities for your PhD Research Proposal. This means you are allowed to embark on your research work for your PhD study

.

Wishing you all the best for studies.

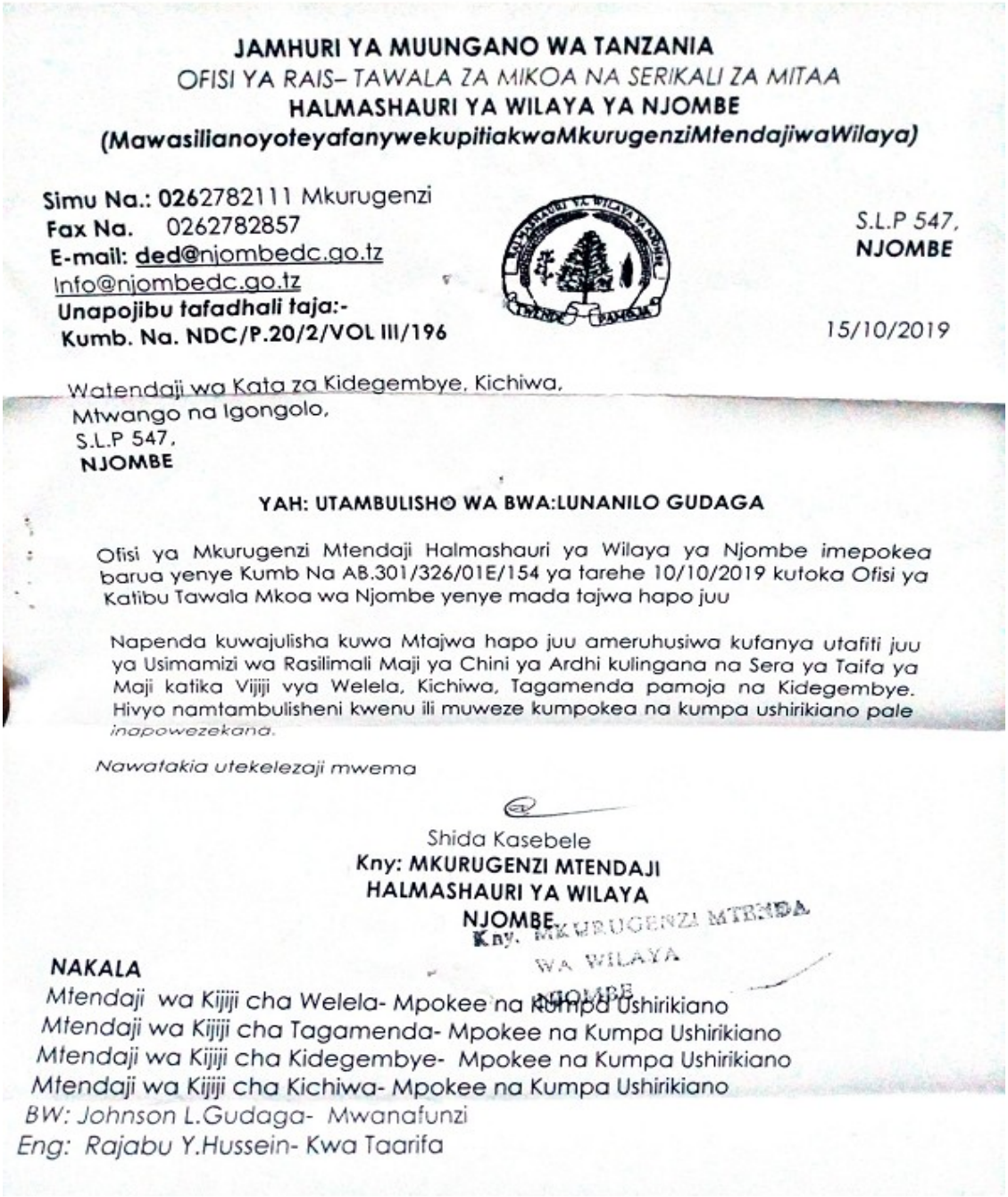
Sincerely,

Mr. D.L Malack
For **DIRECTOR**

Director
Postgraduate studies, Research,
Technology Transfer and Consultancy
Sokoine University of Agriculture
P. O. Box 3151, Morogoro
TANZANIA

c.c. Principal, College of Social Sciences and Humanities
c.c. Chairman College Postgraduate Studies Committee
c.c. Supervisors, Dr. S.J. Kabote and Dr. E.T. Malisa

Appendix 6: Permission letter from the District Executive Director



JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA RAIS– TAWALA ZA MIKOA NA SERIKALI ZA MITAA
HALMASHAURI YA WILAYA YA NJOMBE
(MawasilianoyoteyafanywekupitiakwaMkurugenziMtendajiwaWilaya)

Simu Na.: 0262782111 Mkurugenzi
Fax Na. 0262782857
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Unapojibu tafadhali taja:-
Kumb. Na. NDC/P.20/2/VOL III/196

S.L.P 547,
NJOMBE

15/10/2019

Watendaji wa Kata za Kidegembye, Kichiwa,
Mtwango na Igongolo,
S.L.P 547,
NJOMBE

YAH: UTAMBULISHO WA BWA:LUNANILO GUDAGA

Ofisi ya Mkurugenzi Mtendaji Halmashauri ya Wilaya ya Njombe *imepokea* barua yenye Kumb Na AB.301/326/01E/154 ya tarehe 10/10/2019 kutoka *Ofisi ya* Katibu Tawala Mkoa wa Njombe yenye mada tajwa hapo juu

Napenda kuwajulisha kuwa Mtajwa hapo juu ameruhusiwa kufanya *utafiti juu* ya Usimamizi wa Rasilimali Maji ya Chini ya Ardhi kulingana na Sera ya *Taifa ya* Maji katika Vijiji vya Welela, Kichiwa, Tagamenda pamoja na Kidegembye. Hivyo namtambulisheni kwenu ili muweze kumpokea na kumpa ushirikiano *pale inapowezekana.*

Nawatakia utekelezaji mwema

Shida Kasebele
Kny: MKURUGENZI MTENDAJI
HALMASHAURI YA WILAYA
NJOMBE

Kny. MKURUGENZI MTENDA
WA WILAYA
NJOMBE

NAKALA
Mtendaji wa Kijiji cha Welela- Mpokee na Kumpa Ushirikiano
Mtendaji wa Kijiji cha Tagamenda- Mpokee na Kumpa Ushirikiano
Mtendaji wa Kijiji cha Kidegembye- Mpokee na Kumpa Ushirikiano
Mtendaji wa Kijiji cha Kichiwa- Mpokee na Kumpa Ushirikiano
BW: Johnson L.Gudaga- Mwanafunzi
Eng: Rajabu Y.Hussein- Kwa Taarifa

Appendix 7: Reliability Analysis on the level of groundwater governance

Statements	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Owning properties for groundwater management	101.5280	27.648	.211	.175
Budgeting resources or groundwater management	101.0200	26.967	.080	.142
Allocating groundwater source points	101.1120	28.694	.023	.078
Contributing resources for groundwater management	101.8680	30.356	.213	.146
Formulating by-laws for groundwater management	100.9760	29.766	.172	.106
Giving accounting reports	101.4360	28.279	.014	.078
Accepting challenges related to groundwater management	101.6480	27.370	.135	.035
Accepting challenges from groundwater users	102.7200	28.941	.096	.111
Sharing lessons learned on groundwater management	100.9600	30.882	.261	.160
Explaining openly the rationale for various decisions made	101.5360	28.290	.039	.263
Discussing the accounting reports	102.0280	28.172	.066	.057
Presenting the agenda of groundwater management in meetings	102.4400	27.669	.161	.137
Providing financial statements	102.2880	26.848	.426	.001
Allowing criticism from groundwater users	102.9120	26.691	.148	.022
Giving or accepting apologies when matters have gone wrong	101.5560	29.131	.064	.081
Sharing information from various governance structures	101.7280	29.869	.176	.115
Knowing all source of funds if any	102.4120	27.938	.287	.038
Treating all groundwater users with respect and dignity	102.1960	26.704	.250	.117
Both men and women have opportunity of being leaders	102.3040	28.269	.176	.050
Encouraging groundwater users to contribute resources	101.5080	29.416	.165	.086
Witnessing fair source points allocation	101.4720	28.186	.145	.349
Involving all people on groundwater management regardless their income differences	102.4000	28.434	.276	.053
Involving all people on groundwater management regardless their income differences	101.3000	27.434	.176	.231
Groundwater points are well protected against pollution	102.2880	27.772	.132	.042
Mutual respect among groundwater users to access water	101.4360	28.520	.108	.058
Groundwater points is nearly allocated at the household	100.5080	29.785	.238	.100
Availability of groundwater	101.3000	28.243	.024	.082
Paying the number of contributions as agreed	101.6080	28.328	.010	.076
Prohibiting all socio activities around groundwater points	101.8160	28.095	.002	.073
Giving sanctions to all people who breached water rules regardless their social or economic status	100.9920	28.377	.067	.104
Groundwater management focus on issues not on a person	101.5240	28.162	-.025	.084
Timely disseminating the information	101.6040	27.268	.053	.053
Repairing groundwater infrastructures timely when they have to be repaired	101.7320	27.506	.038	.159
Contributing timely the resources for groundwater management when is needed	101.7600	28.231	-.012	.078
Groundwater users receive timely groundwater related financial reports	101.5520	27.244	.058	.051
Addressing groundwater management challenges	101.5720	27.105	.102	.038
Creating community awareness on groundwater management	101.5400	27.406	.029	.062
Encouraging groundwater users to participate on groundwater management	101.0640	27.032	.019	.166
Enforcing various by- laws of groundwater management	101.7880	28.063	-.001	.074

Reliability Statistics

Cronbach's Alpha	N of Items
.801	39